Table 19. Trees per Acre (TPA[1/]) Left Within the RMZ[2/] of a Westside Stream with a Gradient Between 0% and 20%, Following Harvest Under Alternative 3, Presented in Fixed-width Distance Bands[3/] from the Stream's Bankfull Width, Using a Site Class II Riparian Stand as an Example

		Post-harvest (<20% Gradient)			
DBH Range	Pre-harvest TPA	TPA in Band 1 (0 - 50')	TPA in Band 2 (50 - 80')	TPA in Band 3 (80 - 100')	TPA in Band 4 (100 - 170')[4/]
6" - 12"	160	160	160	160	160
12" - 18"	62	62	62	62	62
18" - 24"	11	11	11	11	11
24" - 30"	0	0	0	0	0
>30"	0	0	0	0	0
Total TPA	233	233	233	233	233
Total BA/acre	152	152	152	152	152

1/ To translate Trees Per Acre into Trees Per 1000 Feet of Stream, multiply the TPA value by 1.15 for Zone 1, by 0.69 for Zone 2, by 0.50 for Zone 3, or by 1.61 for Zone 4.

2/ The calculation of the number of trees remaining in the RMZ following harvest under this alternative does not account for the implementation of CMZs (which increase the area in which leave trees are required within the RMZ).

3/ To facilitate comparison between alternatives, stand data are presented as trees per acre (TPA) within fixed-width distance bands between the stream's bankfull width and the site potential tree height (see Section 3.0, Step 1, Rationale, for a discussion of distance bands).

4/ Under Alternative 3, for streams with a gradient <20%, all trees are retained up to 200 feet from the CMZ or bankfull width. For a Site Class II stand, this is greater than the site potential tree height of 170 feet. However, for modeling LWD recruitment potential, the source area for complete recruitment potential is one site potential tree height; thus only the first 170 feet are considered for this analysis.

Table 20. Trees per Acre (TPA[1/]) Left Within the RMZ[2/] of Westside Streams with a Gradient Between 20% and 30% and for Streams with a Gradient Greater than 30%, Following Harvest Under Alternative 3, Presented in Fixed-width Distance Bands[3/] from the Stream's Bankfull Width, Using a Site Class II Riparian Stand as an Example

		Post-harvest (20% - 30% Gradient)				Post-harvest (>30% Gradient)			
DBH Range	Pre-harvest TPA	TPA in Band 1 (0 - 50')	TPA in Band 2 (50 - 80')	TPA in Band 3 (80 - 100')	TPA in Band 4 (100 - 170')	TPA in Band 1 (0 - 50')	TPA in Band 2 (50 - 80')[/4]	TPA in Band 3 (80 - 100')	TPA in Band 4 (100 - 170')
6" - 12"	160	160	160	160	0	160	107	0	0
12" - 18"	62	62	62	62	0	62	41	0	0
18" - 24"	11	11	11	11	0	11	7	0	0
24" - 30"	0	0	0	0	0	0	0	0	0
>30"	0	0	0	0	0	0	0	0	0
Total TPA	233	233	233	233	0	233	155	0	0
Total BA/acre	152	152	152	152	0	152	102	0	0

1/ To translate Trees Per Acre into Trees Per 1000 Feet of Stream, multiply the TPA value by 1.15 for Zone 1, by 0.69 for Zone 2, by 0.50 for Zone 3, or by 1.61 for Zone 4.

2/ The calculation of the number of trees remaining in the RMZ following harvest under this alternative does not account for the implementation of CMZs (which increase the area in which leave trees are required within the RMZ).

3/ To facilitate comparison between alternatives, stand data are presented as trees per acre (TPA) within fixed-width distance bands between the stream's bankfull width and the site potential tree height (see Section 3.0, Step 1, Rationale, for a discussion of distance bands).

4/ Under Alternative 3 for streams with a gradient >30%, all trees are retained up to 70 feet from the CMZ or bankfull width. This distance falls 10 feet short of the fixed-width band presented in this table. The TPA value for Band 2 reflects the fact that this band contains 20 feet of no-cut zone and 10 feet of clearcut harvest (see Section 3.0, Step 1, under Rationale for a discussion of calculating TPA values for bands which contain varying leave tree densities).

Figure 7a. Westside Trees Remaining in RMZ Under Alternative 3 Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) Along Streams 0-20% Gradient and Totaled by TPA (sub-divided into size class)

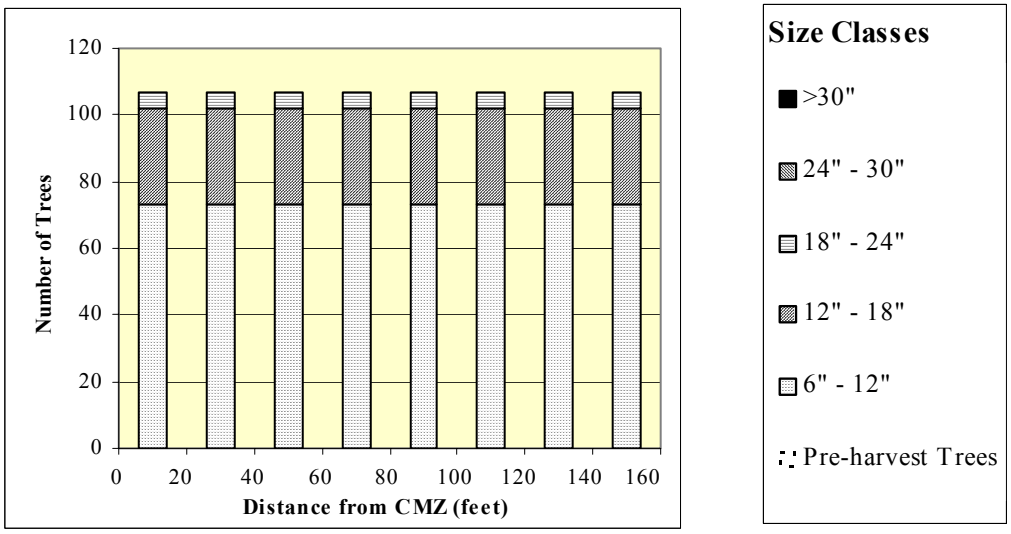


Figure 7b. Westside Trees Remaining in RMZ Under Alternative 3 Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) Along Streams 20-30% Gradient and Totaled by TPA (sub-divided into size class)

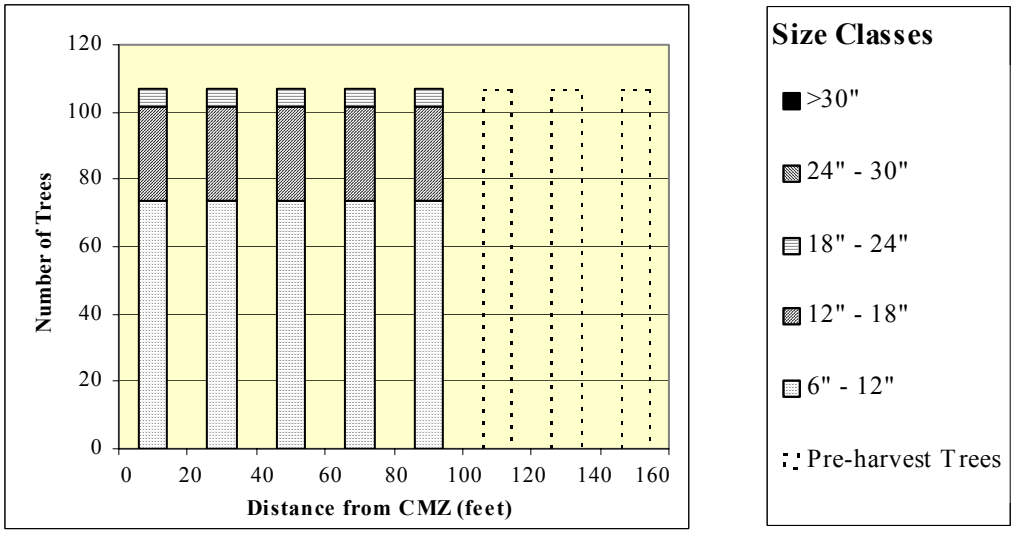
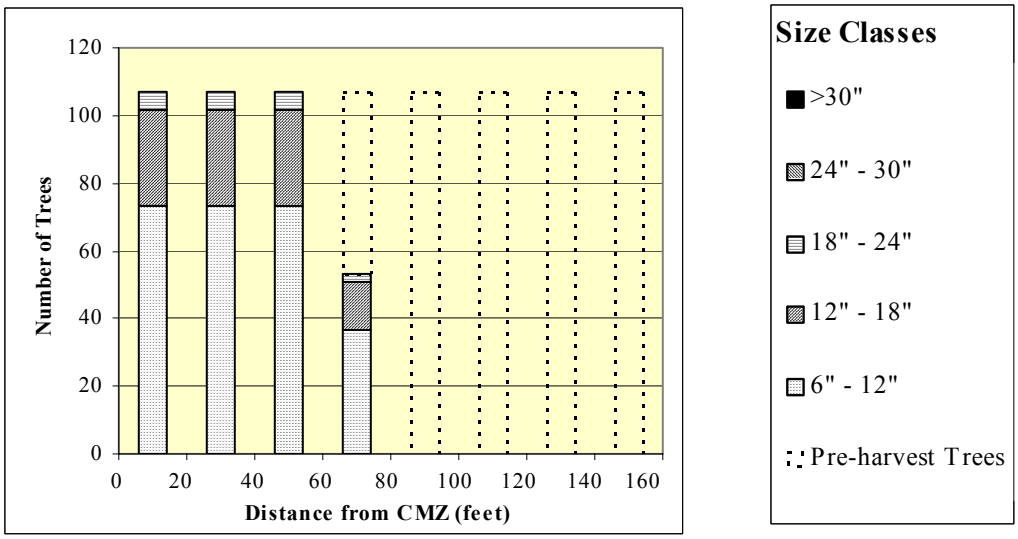


Figure 7c. Westside Trees Remaining in RMZ Under Alternative 3 Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) Along Streams >30% Gradient and Totaled by TPA (sub-divided into size class)



3.1.1 Eastside RMZs

3.1.1.1 General Assumptions

- Model a Mixed Conifer Site Class II riparian stand (site index = 105).
- It is assumed that the riparian stand developed is adjacent to a stream's bankfull width without a channel migration zone (CMZ).
- Trees are distributed evenly through all zones (that is, on a per-acre basis, trees in the Core Zone have the same distribution of diameter and species as trees in the Outer Zone).
- Under Alternative 2 there is a prioritization of species that should be retained when implementing the RMZ prescriptions. However, our data set did not provide this detail and therefore all trees in the representative stand were given equal priority.
- Dominant and co-dominant trees are defined conifers greater than or equal to 20 inches dbh.
- Partial cut harvest (uneven-aged harvest) adjacent to the RMZ, but within the distance of a site potential tree height, is represented by retaining 21 TPA (which is considered the minimum required under this definition) greater than or equal to 10 inches dbh (WAC 222-16-010 and Personal Communication, Debbie Robinson, DNR Forest Practices Staff, 1/05/00).
- Even-aged harvest is defined as retaining 0 TPA. While it is recognized that even-aged harvest in many situations may leave up to 20 TPA, the 0-TPA assumption allows assessment of the greatest possible impact, and permits comparison to the greatest possible impacts as they were modeled under other alternatives.
- No stream-adjacent parallel roads occur within the stand.

3.1.1.2 Assumptions for Alternative 1:

- Model prescriptions for a Type 1, 2, or 3 stream with a cobble-gravel substrate.
- Assume an average RMZ width of 40 feet for units in which partial cut harvest occurs.
- Assume an average RMZ width of 50 feet for units in which even-aged harvest occurs.
- Assume that Wildlife Reserve Tree requirements are met through riparian leave tree retention.
- Along Type 1, 2 and 3 streams, all trees less than 12 inches dbh, 16 conifers 12-20 inches dbh, 3 conifers greater than 20 inches dbh, 3 deciduous trees 12-16 inches dbh, and 2 deciduous trees greater than 16 inches dbh will be left per acre, as dictated by FPRs.
- The representative eastside stand did not differentiate between conifer and hardwood; it is assumed that size class requirements for each tree type can be met within total tree counts.
- Modeled standard partial cut of 21 TPA within 1 SPTH along streams (Type 4 and 5s) that are not provided an RMZ that are within a partial cut timber harvest unit and adjacent to the RMZs that are within the distance of one site potential tree height.
- In even-aged harvest scenarios it was assumed no trees were left adjacent to the RMZ or adjacent to Type 4 and 5 streams

3.1.1.3 Outcome for Alternative 1

Table 21 presents the leave tree density in trees per acre (TPA) in each fixed distance band after Alternative 1 prescriptions were modeled using the eastside representative stand (see Table 14) adjacent to a partial-cut harvest along Types 1, 2, and 3 streams. Table 22 presents the leave tree density in TPA in each fixed distance band after a partial-cut harvest along Type 4 and 5 streams is implemented.

Figures 8a (adjacent to a partial cut harvest), and b (adjacent to an even-aged harvest) are bar graphs that display the leave tree density (in TPA) remaining in the RMZ presented in 20 foot increments from the bankfull width out to the outer edge of the site potential tree height of 110 (Site Class II) after harvest along eastside Type 1, 2 and 3 streams. Figure 8c presents the partial-cut adjacent to Type 4 and 5 streams. Each bar in the figure is segmented by size class (in dbh).

3.1.1.4 Assumptions for Alternative 2

Specific prescriptions for S & F Streams:

Rather than requiring stands to meet Desired Future Conditions, the Forests and Fish report (1999) specifies immediate post-harvest basal area requirements, which vary with habitat type (Ponderosa Pine, Mixed Conifer, or High-Elevation) and Site Class. Sensitivity analysis (see "Sensitivity Analysis" under Step 1, above) detected only minor differences in the effects of each alternative on stands in different habitat types and Site Classes. Therefore, a Mixed Conifer Site Class II (site index = 105) stand was chosen for modeling, since this stand exhibited the greatest variability in the impacts of the alternatives (Table 12).

Table 21. Trees per Acre (TPA[1/]) left Within the RMZ[2/] of an Eastside Type 1, 2, or 3 Stream Following Harvest Under Alternative 1, Presented in Fixed-width Distance Bands[3/] from the Stream's Bankfull Width, Using a Site Class II Riparian Stand as an Example

		Post-harvest (Partial Cut outside RMZ)				Post-harvest (Clearcut outside RMZ)			
DBH Range	Pre-harvest TPA	TPA in Band 1 (0 - 30')	TPA in Band 2 (30 – 75')[4/]	TPA in Band 3 (75 - 100')	TPA in Band 4 (100 - 110')	TPA in Band 1 (0 - 30')	TPA in Band 2 (30 - 75')[4/]	TPA in Band 3 (75 - 100')	TPA in Band 4 (100 - 110')
6" - 12"	149	149	49	21	21	149	66	0	0
12" - 18"	75	21	5	0	0	21	9	0	0
18" - 24"	27	3	1	0	0	3	1	0	0
24" - 30"	9	0	0	0	0	0	0	0	0
>30"	3	0	0	0	0	0	0	0	0
Total TPA	263	173	55	21	21	173	77	0	0
Total BA/acre	246	80	28	13	13	80	36	0	0

1/ To translate Trees Per Acre into Trees Per 1000 Feet of Stream, multiply the TPA value by 0.69 for Zone 1, by 1.03 for Zone 2, by 0.57 for Zone 3, or by 0.23 for Zone 4.

2/ The calculation of the number of trees remaining in the RMZ following harvest under this alternative does not account for the implementation of the shade rule (which may increase the numbers of leave trees remaining in the RMZ) or the fact that only 50 percent of the leave trees left in the RMZ need to be alive (which may reduce the number of trees remaining in the RMZ).

3/ To facilitate comparison between alternatives, stand data are presented as trees per acre (TPA) within fixed-width distance bands between the stream's bankfull width and the site potential tree height (see Section 3.0, Step 1, Rationale, for a discussion of distance bands).

4/ For modeling purposes, a 40-foot no-harvest buffer was assumed along streams within units with a partial cut prescription, and a 50-foot no-harvest buffer was assumed along streams within units with an even-aged prescription. These distances do not correspond exactly to the fixed-width bands presented in this table. The TPA values for Band 2 reflect the fact that this band contains 10 feet of no-cut zone and 35 feet of partial cut under the former prescription, or 20 feet of no-cut and 25 feet of clearcut under the latter (see Section 3.0, Step 1, under Rationale for a discussion of calculating TPA values for bands which contain varying leave tree densities).

Table 22. Trees per Acre (TPA[1/]) Left Adjacent to an Eastside Type 4 or 5 Stream (i.e., having no RMZ) Following Harvest Under Alternative 1 with a Partial Cut Prescription[2/], Presented in Fixed-width Distance Bands[3/] from the Stream's Bankfull Width, Using a Site Class II Riparian Stand as an Example

		Post-harvest[4/]			
DBH Range	Pre-harvest TPA	TPA in Band 1 (0 - 30')	TPA in Band 2 (30 - 75')	TPA in Band 3 (75 - 100')	TPA in Band 4 (100 - 110')
6" - 12"	149	21	21	21	21
12" - 18"	75	0	0	0	0
18" - 24"	27	0	0	0	0
24" - 30"	9	0	0	0	0
>30"	3	0	0	0	0
Total TPA	263	21	21	21	21
Total BA/acre	246	13	13	13	13

1/ To translate Trees Per Acre into Trees Per 1000 Feet of Stream, multiply the TPA value by 0.69 for Zone 1, by 1.03 for Zone 2, by 0.57 for Zone 3, or by 0.23 for Zone 4.

2/ Under an even-aged prescription, it is assumed that no trees would be left within one site potential tree height of Type 4 and 5 streams; the result therefore was not necessary to present in a table.

3/ To facilitate comparison between alternatives, stand data are presented as trees per acre (TPA) within fixed-width distance bands between the stream's bankfull width and the site potential tree height (see Section 3.0, Step 1, Rationale, for a discussion of distance bands).

4/ In this example, the Type 4 and 5 stream is within a partial-cut harvest unit. As a result, even though there is no RMZ, 21 TPA are left in each of the distance bands from the stream's bankfull width.

Figure 8a. Eastside Leave Trees in RMZ for Alternative 1 Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) Along Types 1, 2, and 3 Streams and Totaled by TPA (sub-divided into size class) adjacent to a partial-cut harvest

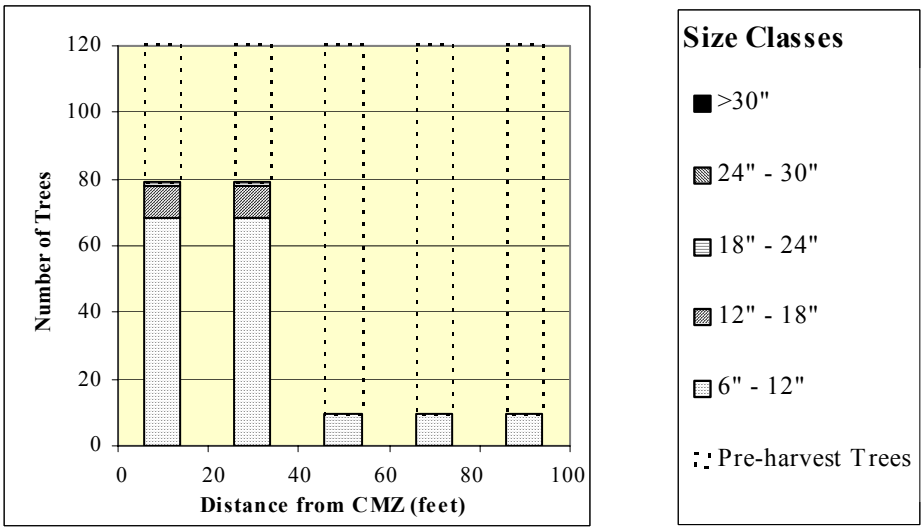


Figure 8b. Eastside Leave Trees in RMZ for Alternative 1 Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) Along Types 1, 2, and 3 Streams and Totaled by TPA (sub-divided into size class) Adjacent to a Even-aged Harvest

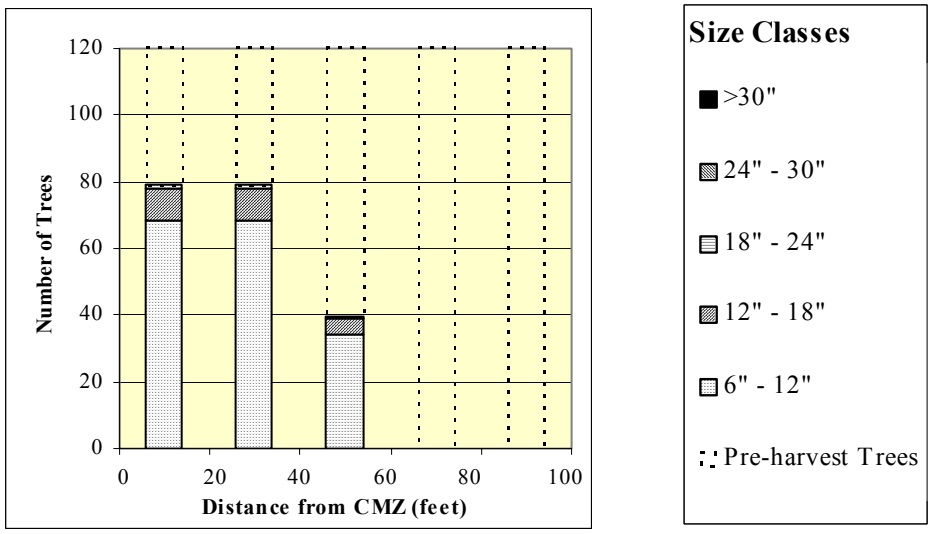
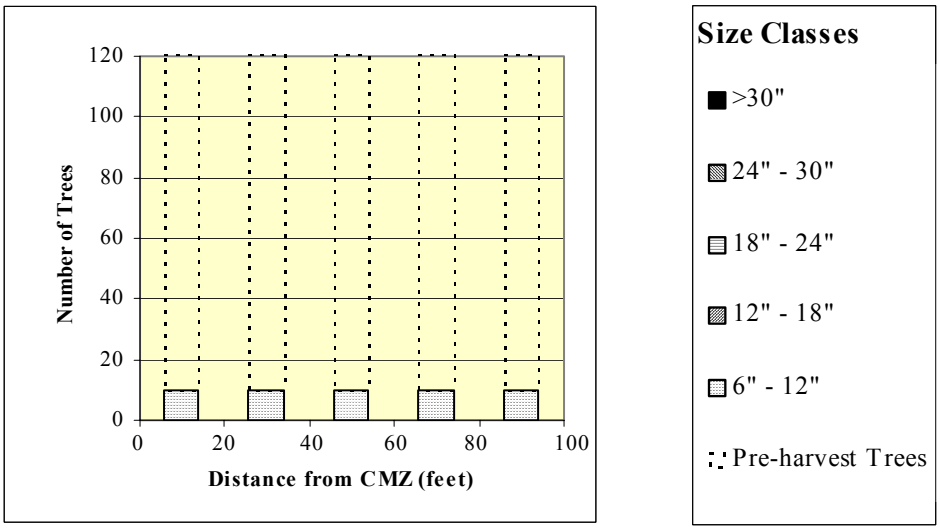


Figure 8c. Eastside Trees Left Adjacent to Type 4 and 5 Streams with no RMZ in a Partial-cut Harvest for Alternative 1 Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) Totaled by TPA (sub-divided into size class) Adjacent to a Even-aged Harvest



Alternative 2 regulations for a Mixed Conifer Site Class II stand require a post-harvest basal area of 90 ft^2/ac in the Inner Zone, and 15 trees per acre in the Outer Zone. Because the most common timber harvest method on the east side is partial cut, an additional 6 trees per acre were modeled as being left in the Outer Zone, to meet the regulatory definition of partial cut as 21 leave trees per acre. Notably, because the Outer Zone is at least 75 feet from the stream's bankfull width, the impact of partial cut *versus* even-aged harvest on LWD recruitment is negligible.

- **Streams less than 15 feet wide,** not in bull trout habitat overlay
  - Core Zone: 30 feet wide, no harvest
  - Inner Zone: 45 feet wide, leave at least 50 TPA after harvest, including the 21 largest trees, and 29 are at least 10 inches dbh. If the resulting basal area is less than 90 ft^2/ac after leaving the 50 TPA, leave enough additional 6-inch-or-greater trees to raise the stand's basal area to 90 ft^2/ac.
  - Outer Zone: 35 feet wide, leave 21 TPA after harvest, of which 15 are at least 20 inches dbh (i.e., dominant or co-dominant).

- **Streams greater than 15 feet wide,** not in bull trout habitat overlay
  - Core Zone: 30 feet wide, no harvest
  - Inner Zone: 70 feet wide, model as for streams less than 15 feet wide.
  - Outer Zone: 10 feet wide, model as for streams less than 15 feet wide.

- **Streams less than 15 feet wide,** within bull trout habitat overlay
  - Core Zone: 30 feet wide, no harvest
  - Inner Zone: 45 feet wide, the restriction of having no effective shade removed was modeled as a no-harvest scenario. This is not to say that harvest will not occur in the inner zone within 75 feet, but allows us to capture the most

restrictive scenario. By comparing a no-harvest scenario within 75 feet of the bankfull width or CMZ to the baseline prescription modeled outside of the bull trout overlay we are able to capture the maximum range between minimum restriction under the FFR in the inner zone to the maximum potential restriction in the range of the bull trout.

- Outer Zone: 35 feet wide, leave 21 TPA after harvest, of which 15 are at least 20 inches dbh.

- **Streams greater than 15 feet wide,** within bull trout habitat overlay
  - Core Zone: 30 feet wide, no harvest
  - Inner Zone: 70 feet wide. The first 45 feet were modeled as no-harvest, to capture the maximum potential restrictions for maintaining all effective shade (see discussion above under streams less than 15 feet within the bull trout overlay). The remaining 25 feet were modeled as described above under "Streams less than 15 feet wide, outside of bull trout overlay."
  - Outer Zone: 10 feet wide, model as for streams less than 15 feet wide.

Specific Prescriptions for Type N_p Streams under a partial-cut strategy:

- Within 50 feet of Type N_p streams leave 10 largest trees per acre; leave as many additional trees per acre to make the resulting basal area $\geq$90 ft^2/ac. The first 40 trees must be $\geq$ 10" dbh and the next 50 trees must be $\geq$ 6" dbh.

- Beyond 50 feet, the standard partial-cut harvest prescription (21 TPA > 10" dbh) out to 1 SPTH was applied.

- All other streams (Type N_s streams) that do not fall within the above prescriptions under the partial cut strategy are assumed to have the standard selective harvest prescription (21 TPA > 10" dbh) for 1 SPTH.

Specific Prescriptions for Type N_p Streams under an even-aged strategy:

- Leave all trees within 50 feet of the stream's bankfull width; clearcut harvest outside of the 50-foot no-cut buffer but within 1 SPTH.

- This no-cut buffer was modeled for 70 percent of the total length of eastside N_p streams. The remaining 30 percent was modeled as a clearcut to the stream's edge.

3.1.1.5 Outcome for Alternative 2

Tables 23 and 24 present the leave tree density in trees per acre (TPA) in each fixed distance band after Alternative 2 prescriptions were modeled using the eastside representative stand (see Table 14) adjacent to a partial-cut and even-aged harvest along S and F streams. Table 23 models stands not within the bull trout overlay and Table 24 models stands within bull trout overlay. Table 25 presents Type N_p stream RMZs after implementing Alternative 2 prescriptions under the partial-cut scenario and under the even-aged scenario. Table 26 presents the leave tree density in TPA in each fixed distance band after partial-cut harvest is implemented adjacent to Type N_s streams (which have no RMZs). Under an even-aged scenario, for modeling purposes it was assumed that all trees were harvested adjacent to N_s streams. As a result, no table was developed.

Table 23. Trees per Acre (TPA[1/]) Left Within the RMZ[2/] of an Eastside Type S or F Stream Following Harvest Under Alternative 2 Outside of the Bull Trout Habitat Overlay Area, Presented in Fixed-width Distance Bands[3/] from the Stream's Bankfull Width, Using a Site Class II Riparian Stand as an Example

		Post-harvest (Streams ≤15 Feet Wide)				Post-harvest (Streams >15 Feed Wide)			
DBH Range	Pre-harvest TPA	TPA in Band 1 (0 - 30')	TPA in Band 2 (30 – 75')	TPA in Band 3 (75 - 100')	TPA in Band 4 (100 - 110')	TPA in Band 1 (0 - 30')	TPA in Band 2 (30 - 75')	TPA in Band 3 (75 - 100')	TPA in Band 4 (100 - 110')
6" - 12"	149	149	29	0	0	149	29	29	0
12" - 18"	75	75	0	0	0	75	0	0	0
18" - 24"	27	27	9	13	13	27	9	9	13
24" - 30"	9	9	9	2	2	9	9	9	2
>30"	3	3	3	0	0	3	3	3	0
Total TPA	263	263	50	15	15	263	50	50	15
Total BA/acre	246	246	91	38	38	246	91	91	38

1/ To translate Trees Per Acre into Trees Per 1000 Feet of Stream, multiply the TPA value by 0.69 for Zone 1, by 1.03 for Zone 2, by 0.57 for Zone 3, or by 0.23 for Zone 4.

2/ The calculation of the number of trees remaining in the RMZ following harvest under this alternative does not account for the implementation of the shade rule or CMZs (which may increase the numbers of leave trees remaining in the RMZ).

3/ To facilitate comparison between alternatives, stand data are presented as trees per acre (TPA) within fixed-width distance bands between the stream's bankfull width and the site potential tree height (see Section 3.0, Step 1, Rationale, for a discussion of distance bands).

Table 24. Trees per Acre (TPA[1/]) Left Within the RMZ[2/] of an Eastside Type S or F Stream Following Harvest Under Alternative 2 Within the Bull Trout Habitat Overlay Area[3/], Presented in Fixed-width Distance Bands[4/] from the Stream's Bankfull Width, Using a Site Class II Riparian Stand as an Example

		Post-harvest (Streams <15 Feet Wide)				Post-harvest (Streams >15 Feet Wide)			
DBH Range	Pre-harvest TPA	TPA in Band 1 (0 - 30')	TPA in Band 2 (30 – 75')	TPA in Band 3 (75 - 100')	TPA in Band 4 (100 - 110')	TPA in Band 1 (0 - 30')	TPA in Band 2 (30 - 75')	TPA in Band 3 (75 - 100')	TPA in Band 4 (100 - 110')
6" - 12"	149	149	149	0	0	149	149	29	0
12" - 18"	75	75	75	0	0	75	75	0	0
18" - 24"	27	27	27	13	13	27	27	9	13
24" - 30"	9	9	9	2	2	9	9	9	2
>30"	3	3	3	0	0	3	3	3	0
Total TPA	263	263	263	15	15	263	263	50	15
Total BA/acre	246	246	246	38	38	246	246	91	38

1/ To translate Trees Per Acre into Trees Per 1000 Feet of Stream, multiply the TPA value by 0.69 for Zone 1, by 1.03 for Zone 2, by 0.57 for Zone 3, or by 0.23 for Zone 4.

2/ The calculation of the number of trees remaining in the RMZ following harvest under this alternative does not account for the implementation of the shade rule or CMZs (which may increase the numbers of leave trees remaining in the RMZ).

3/ The restriction of no removal of all effective shade within the first 75 feet of the bankfull width or CMZ may allow for the same prescription as under Table 23. However, by modeling a no-harvest scenario we are able to capture the range of restriction compared to the baseline prescription modeled in Table 23.

4/ To facilitate comparison between alternatives, stand data are presented as trees per acre (TPA) within fixed-width distance bands between the stream's bankfull width and the site potential tree height (see Section 3.0, Step 1, Rationale, for a discussion of distance bands).

Table 25. Trees per Acre (TPA[1/]) Left Within the RMZ[2/] of an Eastside Type N_p Stream Following Harvest Under Alternative 2, Presented in Fixed-width Distance Bands[3/] from the Stream's Bankfull Width, Using a Site Class II Riparian Stand as an Example

		Post-harvest (Partial Cut outside RMZ)				Post-harvest (Clearcut outside RMZ)			
DBH Range	Pre-harvest TPA	TPA in Band 1 (0 - 30')	TPA in Band 2 (30 – 75')	TPA in Band 3 (75 - 100')	TPA in Band 4 (100 - 110')	TPA in Band 1 (0 - 30')	TPA in Band 2 (30 - 75')	TPA in Band 3 (75 - 100')	TPA in Band 4 (100 - 110')
6" - 12"	149	119	65	21	21	149	66	0	0
12" - 18"	75	3	1	0	0	75	33	0	0
18" - 24"	27	0	0	0	0	27	12	0	0
24" - 30"	9	7	3	0	0	9	4	0	0
>30"	3	3	1	0	0	3	1	0	0
Total TPA	263	132	70	21	21	263	117	0	0
Total BA/acre	246	90	47	13	13	246	110	0	0

1/ To translate Trees Per Acre into Trees Per 1000 Feet of Stream, multiply the TPA value by 0.69 for Zone 1, by 1.03 for Zone 2, by 0.57 for Zone 3, or by 0.23 for Zone 4.

2/ The calculation of the number of trees remaining in the RMZ following harvest under this alternative does not account for the implementation of the shade rule or CMZs (which may increase the numbers of leave trees remaining in the RMZ).

3/ To facilitate comparison between alternatives, stand data are presented as trees per acre (TPA) within fixed-width distance bands between the stream's bankfull width and the site potential tree height (see Section 3.0, Step 1, Rationale, for a discussion of distance bands).

Table 26. Trees per Acre (TPA[1/]) Left Adjacent to an Eastside Type N_s Stream (i.e., having no RMZ) Following Harvest Under Alternative 2 with a Partial Cut Prescription[2/], Presented in Fixed-width Distance Bands[3/] from the Stream's Bankfull Width, Using a Site Class II Riparian Stand as an Example

		Post-harvest[4/]			
DBH Range	Pre-harvest TPA	TPA in Band 1 (0 - 30')	TPA in Band 2 (30 - 75')	TPA in Band 3 (75 - 100')	TPA in Band 4 (100 - 110')
6" - 12"	149	21	21	21	21
12" - 18"	75	0	0	0	0
18" - 24"	27	0	0	0	0
24" - 30"	9	0	0	0	0
>30"	3	0	0	0	0
Total TPA	263	21	21	21	21
Total BA/acre	246	13	13	13	13

1/ To translate Trees Per Acre into Trees Per 1000 Feet of Stream, multiply the TPA value by 0.69 for Zone 1, by 1.03 for Zone 2, by 0.57 for Zone 3, or by 0.23 for Zone 4.

2/ Under an even-aged prescription, it is assumed that no trees would be left within one site potential tree height of Type 4 and 5 streams; the result therefore was not necessary to present in a table.

3/ To facilitate comparison between alternatives, stand data are presented as trees per acre (TPA) within fixed-width distance bands between the stream's bankfull width and the site potential tree height (see Section 3.0, Step 1, Rationale, for a discussion of distance bands).

4/ In this example, the Type 4 and 5 stream is within a partial-cut harvest unit. As a result, even though there is no RMZ, 21 TPA are left in each of the distance bands from the stream's bankfull width.

Figures 9a, b , c, d, e, f and g are bar graphs that displays the leave tree density (in TPA) remaining in the RMZ presented in 20 foot increments from the bankfull width out to the outer edge of the site potential tree height (site class II) after harvest along Type S, F streams ($\leq$ and > 15 feet) within and outside of the bull trout overlay, N_p streams with an even-aged strategy and with a partial cut

strategy and N_s streams adjacent to partial-cut harvest. Each bar in the figure is segmented by size class (in dbh).

Figure 9a. Eastside Trees Remaining in RMZ D-42 Under Alternative 2 ≤15 Feet Outside of the Bull Trout Overlay Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) Along Types S, F Streams and Totaled by TPA (sub-divided into size class)

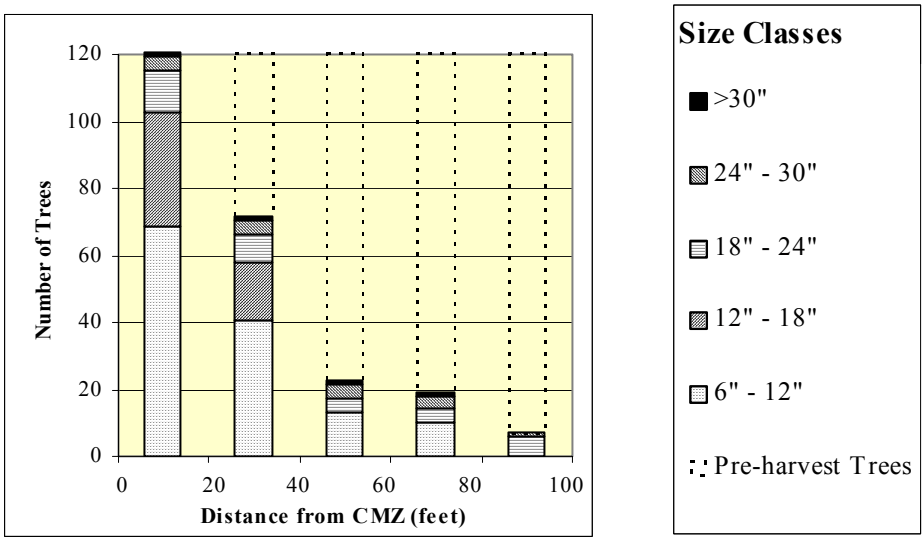


Figure 9b. Eastside Trees Remaining in RMZ Under Alternative 2 >15 Feet Outside of the Bull Trout Overlay Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) Along Types S, F Streams and Totaled by TPA (sub-divided into size class)

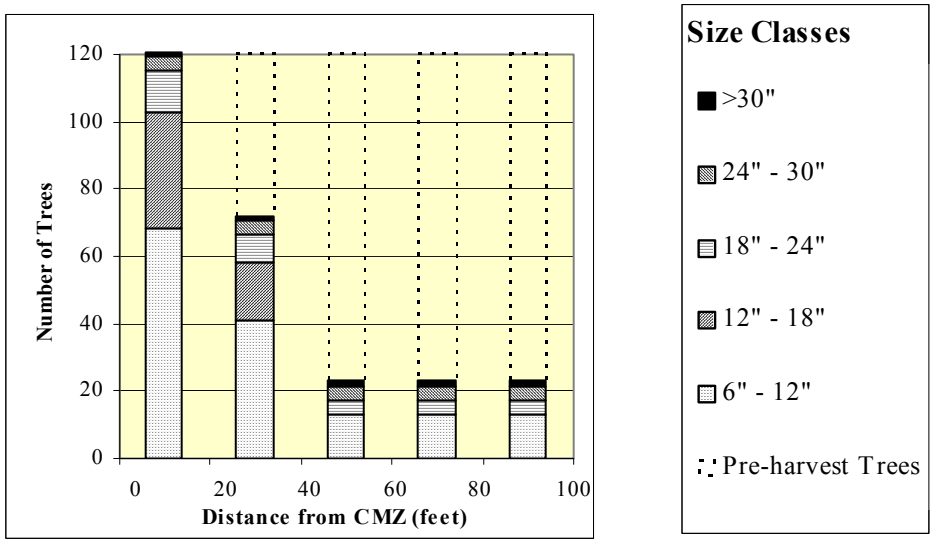


Figure 9c. Eastside Trees Remaining in RMZ Under Alternative 2 ≤15 Feet Within the Bull Trout Overlay Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) Along Types S, F Streams and Totaled by TPA (sub-divided into size class)

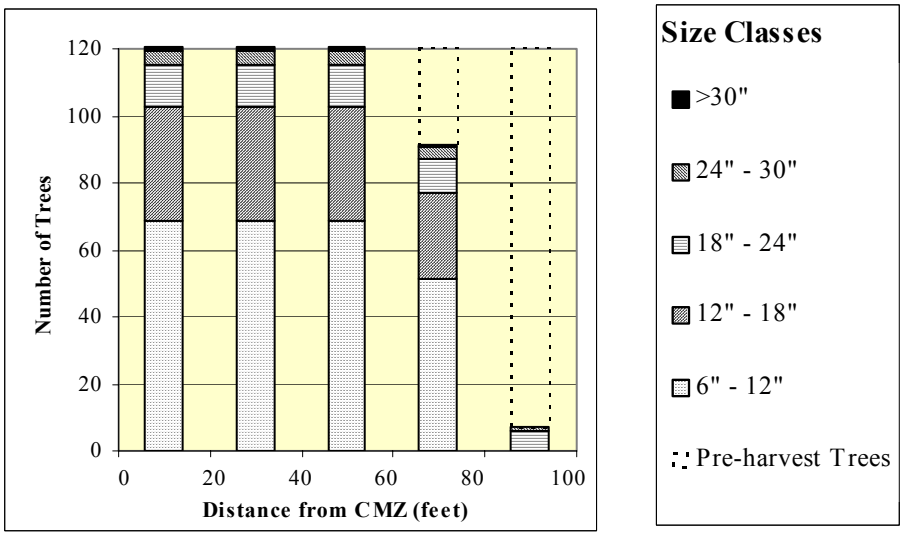


Figure 9d. Eastside Trees Remaining in RMZ Under Alternative 2 >15 Feet Within the Bull Trout Overlay Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) Along Types S, F Streams and Totaled by TPA (sub-divided into size class)

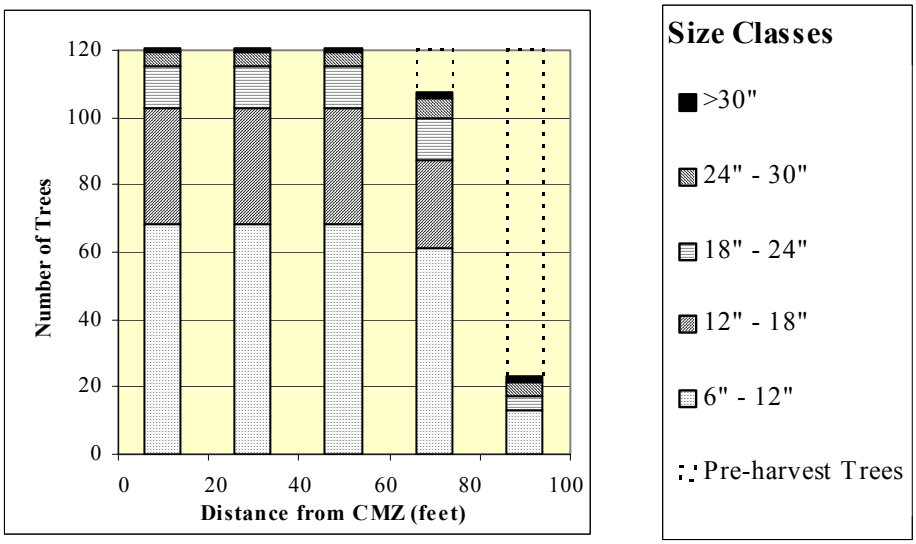


Figure 9e. Eastside Trees Remaining in RMZ Under Alternative 2 Along N_p Streams Within a Selective Harvest Strategy Presented in 20-foot Increments (measured from bankfull width out to the Outer Edge of the SPTH) and Totaled by TPA (sub-divided into size class)

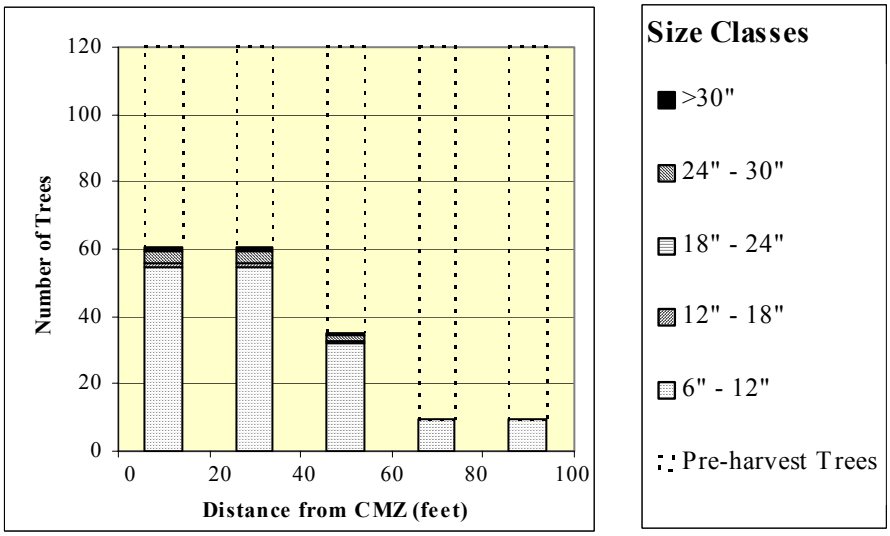


Figure 9f. Eastside Trees Remaining in RMZ Under Alternative 2 Along N_p Streams Within a Even-age Strategy Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) and Totaled by TPA (sub-divided into size class)

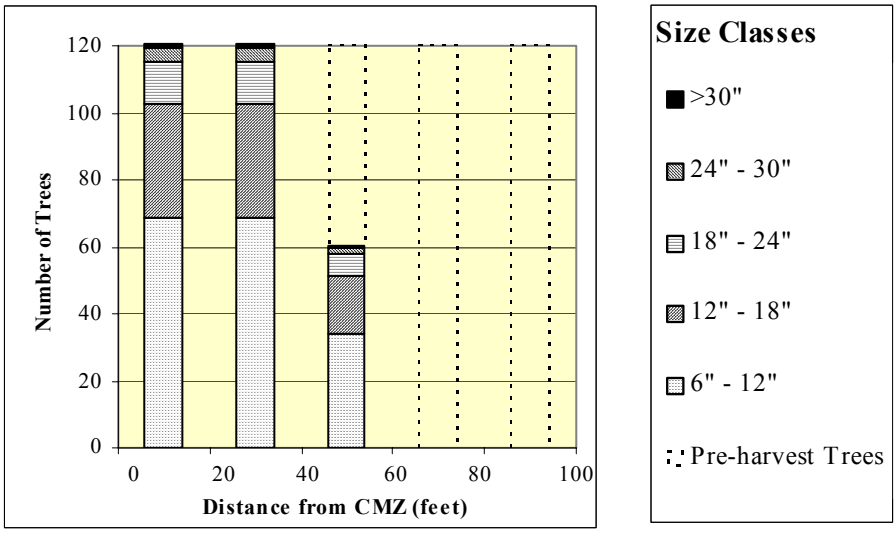
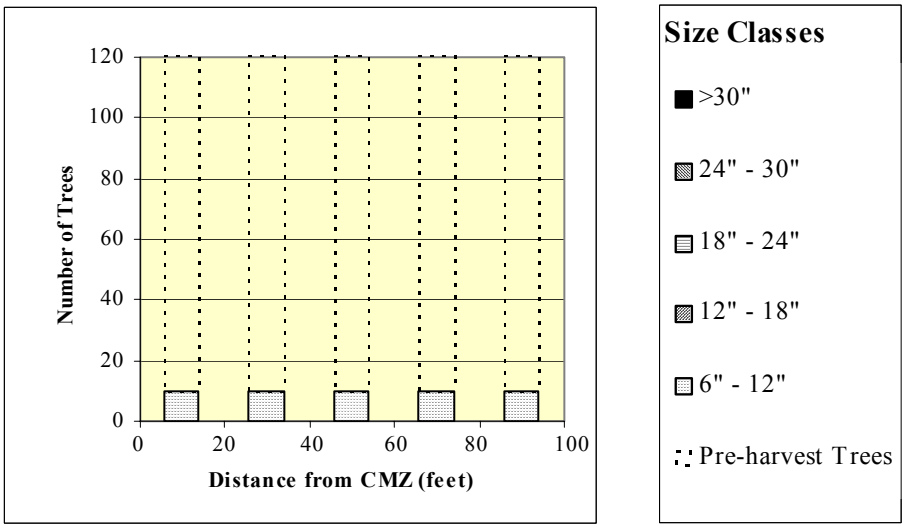


Figure 9g. Eastside Trees Remaining Adjacent to Type N_s streams Under Alternative 2 Within a Partial-cut Harvest Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) and Totaled by TPA (sub-divided into size class)



3.1.1.6 Assumptions for Alternative 3

- Alternative 3 was modeled assuming no harvest adjacent to the stream (though landowners would be allowed to harvest within the RMZ if they go through SEPA), and selective harvest outside of the RMZ but for the remainder of 1 SPTH.

- The width of the no-harvest buffer was determined by stream gradient: a no-harvest buffer of 200 feet around streams with a gradient less than 20 percent, 100 feet around streams with a gradient between 20 percent and 30 percent, and 70 feet around streams with a gradient greater than 30 percent.

3.1.1.7 Outcome for Alternative 3

Tables 27 and 28 present the leave tree density in trees per acre (TPA) remaining in each RMZ band after Alternative 3 prescriptions were modeled using the eastside representative stand (see Table 14) along streams with 0 to 20 percent, 20 to 30 percent, and >30 percent gradient, respectively. Table 27 presents the results of modeling the RMZ prescriptions along streams 0 to 20 percent gradient. Table 28 presents the results of modeling the RMZ prescriptions along streams 20 to 30 percent and >30 percent gradient.

Figures 10 a, b, and c are bar graphs that displays the leave tree density (in TPA) remaining in the RMZ presented in 20 foot increments from the bankfull width out to the outer edge of the site potential tree height (Site Class II) after harvest along streams 0 to 20 percent, 20 to 30 percent, and >30 percent gradient. Each bar in the figure is segmented by size class (in dbh).

Table 27. Trees per Acre (TPA[1/]) Left Within the RMZ[2/] of an Eastside Stream with a Gradient Between 0% and 20%, Following Harvest Under Alternative 3, Presented in Fixed-width Distance Bands[3/] from the Stream's Bankfull Width, Using a Site Class II Riparian Stand as an Example

		Post-harvest (<20% Gradient)			
DBH Range	Pre-harvest TPA	TPA in Band 1 (0 - 30')	TPA in Band 2 (30 - 75')	TPA in Band 3 (75 - 100')	TPA in Band 4 (100 - 110')[4/]
6" - 12"	149	149	149	149	149
12" - 18"	75	75	75	75	75
18" - 24"	27	27	27	27	27
24" - 30"	9	9	9	9	9
>30"	3	3	3	3	3
Total TPA	263	263	263	263	263
Total BA/acre	246	246	246	246	246

1/ To translate Trees Per Acre into Trees Per 1000 Feet of Stream, multiply the TPA value by 0.69 for Zone 1, by 1.03 for Zone 2, by 0.57 for Zone 3, or by 0.23 for Zone 4.

2/ The calculation of the number of trees remaining in the RMZ following harvest under this alternative does not account for the implementation of CMZs (which increase the area in which leave trees are required within the RMZ).

3/ To facilitate comparison between alternatives, stand data are presented as trees per acre (TPA) within fixed-width distance bands between the stream's bankfull width and the site potential tree height (see Section 3.0, Step 1, Rationale, for a discussion of distance bands).

4/ Under Alternative 3, for streams with a gradient <20%, all trees are retained up to 200 feet from the CMZ or bankfull width. For a Site Class II stand, this is greater than the site potential tree height of 110 feet. However, for modeling LWD recruitment potential, the source area for complete recruitment potential is one site potential tree height; thus only the first 110 feet are considered for this analysis.

Table 28. Trees per Acre (TPA[1/]) Left Within the RMZ[2/] of Eastside Streams with a Gradient Between 20% and 30% and for Streams with a Gradient Greater than 30%, Following Harvest Under Alternative 3, Presented in Fixed-width Distance Bands[3/] from the Stream's Bankfull Width, Using a Site Class II Riparian Stand as an Example

		Post-harvest (20% - 30% Gradient)				Post-harvest (>30% Gradient)			
DBH Range	Pre-harvest TPA	TPA in Band 1 (0 - 30')	TPA in Band 2 (30 – 75')	TPA in Band 3 (75 - 100')	TPA in Band 4 (100 - 110')	TPA in Band 1 (0 - 30')	TPA in Band 2 (30 - 75')[4/]	TPA in Band 3 (75 - 100')	TPA in Band 4 (100 - 110')
6" - 12"	149	149	149	149	0	149	133	0	0
12" - 18"	75	75	75	75	0	75	67	0	0
18" - 24"	27	27	27	27	0	27	24	0	0
24" - 30"	9	9	9	9	0	9	8	0	0
>30"	3	3	3	3	0	3	3	0	0
Total TPA	263	263	263	263	0	263	234	0	0
Total BA/acre	246	246	246	246	0	246	219	0	0

1/ To translate Trees Per Acre into Trees Per 1000 Feet of Stream, multiply the TPA value by 0.69 for Zone 1, by 1.03 for Zone 2, by 0.57 for Zone 3, or by 0.23 for Zone 4.

2/ The calculation of the number of trees remaining in the RMZ following harvest under this alternative does not account for the implementation of CMZs (which increase the area in which leave trees are required within the RMZ).

3/ To facilitate comparison between alternatives, stand data are presented as trees per acre (TPA) within fixed-width distance bands between the stream's bankfull width and the site potential tree height (see Section 3.0, Step 1, Rationale, for a discussion of distance bands).

4/ Under Alternative 3 for streams with a gradient >30%, all trees are retained up to 70 feet from the CMZ or bankfull width. This distance falls 5 feet short of the fixed-width band presented in this table. The TPA value for Band 2 reflects the fact that this band contains 40 feet of no-cut zone and 5 feet of clearcut harvest (see Section 3.0, Step 1, under Rationale for a discussion of calculating TPA values for bands which contain varying leave tree densities).

Figure 10a. Eastside Trees Remaining in RMZ Under Alternative 3 Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) Along Streams 0-20% Gradient and Totaled by TPA (sub-divided into size class)

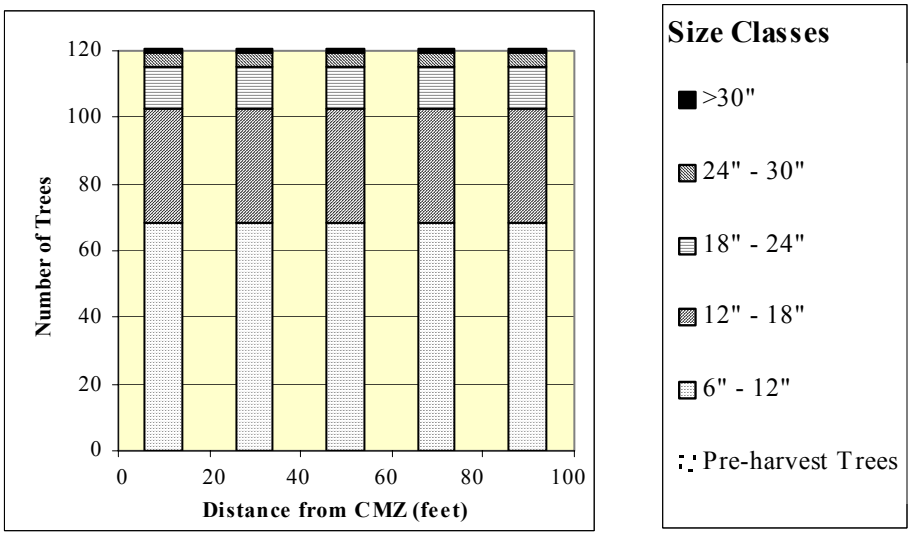


Figure 10b. Eastside Trees Remaining in RMZ Under Alternative 3 Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) Along Streams 20-30% Gradient and Totaled by TPA (sub-divided into size class)

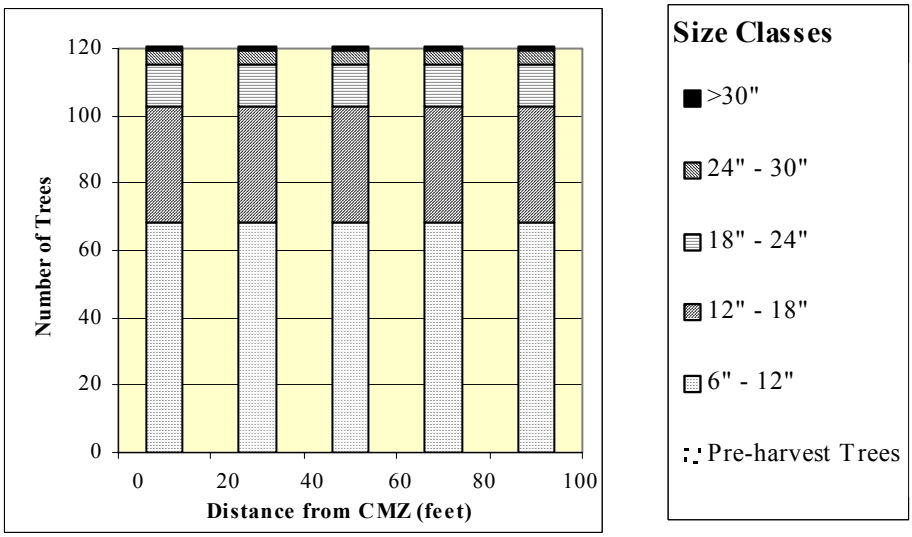
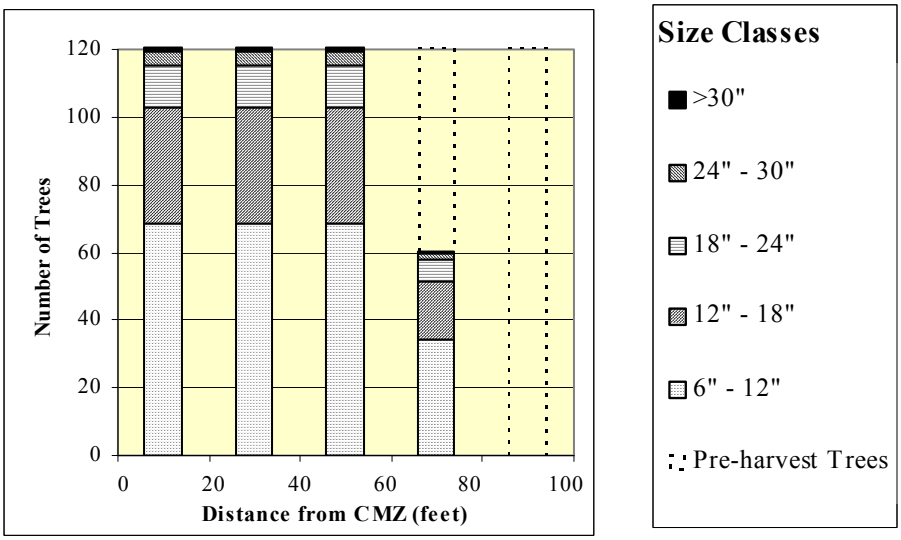


Figure 10c. Eastside Trees Remaining in RMZ Under Alternative 3 Presented in 20-foot Increments (measured from bankfull width out to the outer edge of the SPTH) Along Streams >30% Gradient and Totaled by TPA (sub-divided into size class)



3.2 Step 3: Defining size of leave trees considered "functional" LWD if recruited.

3.2.1 Rationale

Both the size of the leave trees left in the RMZ and the size of the adjacent channel was taken into consideration when developing the RPI because of the strong relationship between channel width, and the size of LWD that forms a pool (Bilby and Ward, 1989; Bilby and Wasserman; Beechie and Sibley, 1997; Beechie, 1998). As a result, after harvesting the trees in the RMZ, the only trees considered in the development of the RPI coefficient are trees that are also considered "functional" as LWD, if recruited into a stream or river. Though only a certain percentage of functionally sized LWD may actually create pools, the greater proportion recruited will ensure a greater potential for pool formation. Data from western Washington indicate that 3 of 10 pieces of functionally-sized LWD create pools (Kennard and Pess, in press; Montgomery et al., 1995).

3.2.2 Assumptions

- Separate eastside and westside functional LWD size/stream width were used based on Bilby and Wasserman (1989) conclusions which included: 1) there was great variation in tree density in unmanaged riparian areas along the eastside streams; due to the more homogeneous climatic conditions prevailing in western Washington, it is likely that variability in stand density is less, and 2) hydrologic conditions in eastern Washington display smaller extremes than on the west side, due to the fact that most high discharges in eastern Washington are governed by snowmelt runoff, versus heavy winter rains or rain on snow on the west side of the Cascades (Bilby and Wasserman, 1989).

- Eastern Washington and western Washington follow a similar pattern between the average piece diameter of LWD and stream size; however, the piece size considered functional was smaller in eastern Washington streams than in similarly sized systems west of the Cascades (Bilby and Wasserman, 1989).

- The analysis used the mean LWD diameter considered functional by stream width based upon Bilby and Ward (1989) for the west side and Bilby and Wasserman (1989) for the east side (Tables 29 and 30). Some pieces smaller than these mean diameters may also serve as functional LWD. Consequently, this assumption would tend to underestimate the recruitment potential from the modeled stands. .

- Average stream width assigned to each stream type under Alternative 1 was used to determine average dbh that would be used to determine functional size for the leave trees in the RMZ (Tables 29 and 30).

- Key piece size, which is considered a subset of "functional LWD" was not incorporated into the EBAI. Key piece size includes pool forming capacity similar to "functional wood size" but also takes into consideration effectiveness in trapping other smaller more mobile pieces of LWD (forming logjams) as well as long-term stability that is resistant to any movement. The watershed analysis manual identifies the specific LWD sizes that meet the key-piece definition. These sizes are based on data collected by Fox (unpublished). Similar to Bilby and Ward (1989), Bilby and Wasserman (1989), Beechie and Sibley (1997), and Beechie (1998), minimum LWD size increases with channel width (Washington Forest Practices Board, 1995). In this EIS analysis, we focused on long-term sources of functional-sized LWD rather than key pieces. Nevertheless, a sensitivity analysis was conducted to see if there would be a different relationship that would develop if key piece size rather then functional size was used to develop the RPI coefficient in Step 5. There was relatively little or no difference in the final outcome in Step 5 (final calculation of the RPI coefficient). However, there was a difference in the outcome under long-term modeling in Section 4.0 of this appendix. Key pieces and functional LWD sizes are also discussed under LWD in Section 3.4.2.1 of the EIS.

Table 29. Westside Functional LWD Based on Stream Width[1/]

Water Type	Westside Channel Width (ft)	Mean LWD Diameter (in)
1	44	21.7
2	31	18.4
3	15	14.3
4 F	5	11.7
4s & 5s	5	11.7

[1/] The relationship between the LWD diameter and channel width (CW) was defined by Bilby and Ward (1989) as LWD diameter(cm)=CW(m)*2.14+26.43

Table 30. Eastside Functional LWD Based on Stream Width[2/]

Water Type	Eastside Channel Width (ft)	Mean LWD Diameter (in)
1	45	11.9
2	25	9.8
3	12	8.4
4 F	5	7.7
4s & 5s	5	7.7

[2/] The relationship between the LWD diameter and channel width (CW) was defined by Bilby and Wasserman (1989) as LWD diameter(cm)=CW(m)*0.87+18.20

3.3 Step 4: Calculating relative percent of LWD recruitment potential from selected distance categories based on 1 SPTH.

3.3.1 Rationale

Under natural conditions most of the LWD entering reaches from the adjacent riparian zone originated from within one site potential tree height of the stream (McDade et al., 1990; Vansickle and Gregory, 1990). However, the relationship between buffer width and potential LWD inputs from the adjacent riparian zone is non-linear (see Figure 3.4-1 in the EIS) with a greater percentage of LWD recruitment occurring closer to the stream. Therefore, when calculating LWD recruitment potential, cumulative percentage of debris pieces left from different portions of the RMZ needs to be computed.

3.3.2 Assumptions

- McDade et al.'s (1990) assessment of percent contribution of LWD from selected distance categories (see Figure 3.4-1) was used to determine cumulative percent of LWD recruitment (using their mature conifer curve).

- The mature conifer curve, rather than McDade's old-growth curve, was used primarily because most of Washington's private and state timber lands have been harvested at least once and many are currently in early seral stage (see Figure 3.4-1). Therefore, the recruitment potential that exists within the time-frame of the proposed rules would fall within the mature conifer source distance (McKinley, 1997) rather then the old-growth source distance which generally would not be achieved for a much greater time-frame (over 200 years).

- When calculating cumulative percent it is assumed that 100 percent potential recruitment exists when: (1) The RMZ is the same width as 1 site-potential tree (based on a 100 year old Douglas-fir stand on both west side and east side); (2) there is no-harvest within the RMZ, so all trees of appropriate size are recruitable.

- To facilitate comparison, RMZs were divided into the same four fixed distance bands from the streams bank bankfull width to the site potential tree height as described and explained under Steps 1 and 2. For example, for a westside Site Class II stand (SPTH = 170 feet), Band 1 (0-50 feet) contributes approximately 70 percent of LWD source trees, Band 2 (50 to 80 feet) contributes 16.5 percent, Band 3 contributes 7 percent, and Band 4 contributes 6 percent (Table 31a).

- On the west side, the Site Class II that was used for modeling has a SPTH of 170 feet, which matches the distance used in the McDade curve. Therefore, the cumulative LWD contribution from each distance band was directly taken from that curve. The eastside representative stand has a SPTH of 110 feet. To allow for varying SPTH, we converted distance values on McDade's mature conifer curve (the x axis in Figure 3.4-1) into percentages of the SPTH distance. The cumulative contribution of LWD (the y axis in Figure 3.4-1) from each distance band could then be calculated independent of SPTH. As an example, for a SPTH of 110 feet, a distance of 30 feet is approximately 27 percent of the SPTH. On McDade's curve, the first 27 percent of a SPTH contributes approximately 65 percent of the source trees (Figure 3.4-1, Table 31b).

Table 31a. Fixed Distance Bands[1/] Grouped by Cumulative Percent Based on Distance to Stream for one 100-year SPTH of 170 Feet on the West Side

Region	Band 1 (0 – 50ft)	Band 2 (50 – 80ft)	Band 3 (80 – 100ft)	Band 4 (100 –170ft)	Total
West side	70.0%	16.5%	7.5%	6.0%	100.0%

[1/] The cumulative percent was presented within fixed distance bands from the streams bankfull width out to the site potential tree height of the stand site class to facilitate comparison between alternatives (see Section 3.0, Step 1, Rationale for details regarding the fixed distance bands)

Table 31b. Fixed Distance Bands[1/] grouped by cumulative percent based on distance to stream for one 100-year SPTH of 110 feet on the east side

Region	Band 1 (0 – 30ft)	Band 2 (30 – 75ft)	Band 3 (75 – 100ft)	Band 4 (100 – 110ft)	Total
East side	65.0%	31.0%	2.5%	1.5%	100.0%

[1/] The cumulative percent was presented within fixed distance bands from the streams bankfull width out to the site potential tree height of the stand site class to facilitate comparison between alternatives (see Section 3.0, Step 1, Rationale for details regarding the fixed distance bands).

3.4 Step 5: Final calculation of RPI Coefficient.

3.4.1 Rationale

Once the cumulative percent based on distance from stream grouped by fixed bands is determined, and the number of functional size leave trees expected in a no-harvest riparian area is calculated, and differing silivicultural prescriptions are applied to the RMZ then the final RPI can be calculated.

3.4.2 Assumptions

- The calculated RPI is based on comparing the number of leave trees remaining in the RMZ by fixed band to the number of trees in the same zone if no prescription were implemented (i.e. no-harvest). Thus, coefficients used in the analysis are relative to 100 percent potential. However, the complete potential of each zone is only the proportion of the cumulative percent found in the specific band. For example, on the westside band 4 can only provide 6 percent of the total recruitment potential if all trees are left. If trees are harvested in this zone then the proportion that is left is based on the total 6 percent that would have been available for recruitment.

- The trees that are counted as leave trees in each zone of the RMZ when calculating the RPI for different stream widths is based on the dbh that is considered functional if recruited to the stream the prescription is being applied. For example, for a westside stream that is 45 feet wide a tree 22 inch dbh or greater were counted as leave trees. For a stream that averages 5 feet wide trees 12 inch dbh or greater were considered leave trees.

Note that a small bias is present when modeled RMZ boundaries are not identical to band widths. For example under Alternative 1, the modeled RMZ width is 40 feet, but Band 1 is 50 feet wide. About 59 percent of the full recruitment potential would come from within a 40-foot band based upon McDade et al. (1990) and a 170-foot SPTH. However, the EBAI model spreads the recruitable trees from the 40-foot RMZ over a 50-foot wide band. In other words, only four-fifths (80 percent) of the full number of trees would be present in the 50-foot band. This effectively reduces the available LWD recruitment potential to 56 percent (80 percent of the trees times 70 percent of full recruitment potential). The magnitude of the bias would be smaller for other bands because the proportion of the full recruitment potential is lower for these bands.

3.4.3 Results

Tables 32 through 34 present EBAI values for westside streams of varying widths, following harvest within the RMZ under Alternatives 1, 2, and 3, respectively. Tables 35 through 37 do the same for eastside streams.

Table 32. Number of Functional Trees and Contribution to the Recruitment Potential Index (RPI) in Each Distance Band, Following Timber Harvest within One 100-year Site Potential Tree Height for Westside Streams: Alternative 1

Westside Stream Type	Avg. Stream Width		Band 1 (0-50 ft)	Band 2 (50-80 ft)	Band 3 (80-100 ft)	Band 4 (100-170)	Total[1/] (170 ft)
Alternative 1							
Type 1	44 ft	# of trees	1	0	0	0	1
		RPI	56%	0%	0%	0%	56%
Type 2	31 ft	# of trees	2	0	0	0	2
		RPI	12%	0%	0%	0%	12%
Type 3	15 ft	# of trees	39	0	0	0	39
		RPI	56%	0%	0%	0%	56%
Type 4/5	5 ft	# of trees	0	0	0	0	0
		RPI	0.0%	0%	0%	0%	0%

[1/] The sum of the RPI contributions from all four distance bands is the value used for the final EBAI analysis.

Table 33. Number of Functional Trees and Contribution to the Recruitment Potential Index (RPI) in Each Distance Band, Following Timber Harvest within One 100-year Site Potential Tree Height for Westside Streams: Alternative 2

Westside Stream Type	Avg. Stream Width		Band 1 (0-50 ft)	Band 2 (50-80 ft)	Band 3 (80-100 ft)	Band 4 (100-170)	Total[1/] (170 ft)
Alternative 2							
Option 1							
S&F	5 ft	# of trees	84	40	26	43	**193**
		RPI	70%	13%	6%	2%	**91%**
	15 ft	# of trees	49	29	19	27	**125**
		RPI	70%	17%	8%	2%	**96%**
	31 ft	# of trees	13	8	5	7	**33**
		RPI	70%	17%	8%	2%	**96%**
	44 ft	# of trees	2	1	1	1	**5**
		RPI	70%	17%	8%	2%	**96%**
Option 2							
S&F	5 ft	# of trees	84	50	23	42	**198**
		RPI	70%	17%	5%	2%	**94%**
	15 ft	# of trees	49	29	19	7	**104**
		RPI	70%	17%	8%	1%	**95%**
'	31 ft	# of trees	13	8	5	0	**26**
		RPI	70%	17%	8%	0%	**94%**
	44 ft	# of trees	2	1	1	0	**4**
		RPI	70%	17%	8%	0%	**94%**
N_p (No harv.)	5 ft	# of trees	84	0	0	0	**84**
		RPI	70%	0%	0%	0%	**70%**

[1/] The sum of the RPI contributions from all four distance bands is the value used for the final EBAI analysis.

Table 34. Number of Functional Trees and Contribution to the Recruitment Potential Index (RPI) in Each Distance Band, Following Timber Harvest within One 100-year Site Potential Tree Height for Westside Streams: Alternative 3

Westside Stream Type	Avg. Stream Width		Band 1 (0-50 ft)	Band 2 (50-80 ft)	Band 3 (80-100 ft)	Band 4 (100-170)	Total[1/] (170 ft)
Alternative 3							
0-20 % gradient	5 ft	# of trees	84	50	33	117	**284**
		RPI	70%	17%	8%	6%	**100%**
	15 ft	# of trees	49	29	19	68	**165**
		RPI	70%	17%	8%	6%	**100%**
	31 ft	# of trees	13	8	5	18	**44**
		RPI	70%	17%	8%	6%	**100%**
	44 ft	# of trees	2	1	1	3	**6**
		RPI	70%	17%	8%	6%	**100%**
20-30 % gradient	5 ft	# of trees	84	50	33	0	**167**
		RPI	70%	17%	8%	0%	**94%**
	15 ft	# of trees	49	29	19	0	**97**
		RPI	70%	17%	8%	0%	**94%**
	31 ft	# of trees	13	8	5	0	**26**
		RPI	70%	17%	8%	0%	**94%**
	44 ft	# of trees	2	1	1	0	**4**
		RPI %	70%	17%	8%	0%	94%
>30% gradient	5 ft	# of trees	84	33	0	0	117
		RPI	70%	11%	0%	0%	81%
	15 ft	# of trees	49	19	0	0	68
		RPI	70%	11%	0%	0%	81%
	31 ft	# of trees	13	5	0	0	18
		RPI	70%	11%	0%	0%	81%
	44 ft	# of trees	2	1	0	0	3
		RPI	70%	11%	0%	0%	81%

[1/] The sum of the RPI contributions from all four distance bands is the value used for the final EBAI analysis.

Table 35. Number of Functional Trees and Contribution to the Recruitment Potential Index (RPI) in Each Distance Band, Following Timber Harvest within One 100-year Site Potential Tree Height for Eastside Streams: Alternative 1 [1/]

Eastside Stream Type	Avg. Stream Width		Band 1 (0-30 ft)	Band 2 (30-75 ft)	Band 3 (75-100 ft)	Band 4 (100-110)	Total[2/] (110 ft)
Alternative 1							
Type 1	45 ft	# of trees	17	6	0	0	**22**
		RPI	14%	1%	0%	0%	**15%**
Type 2	25 ft	# of trees	42	31	12	5	**90**
		RPI	26%	6%	0%	0%	**33%**
Type 3	12 ft	# of trees	69	40	12	5	**126**
		RPI	34%	6%	0%	0%	**41%**
Type 4/5 (std. SH)[2/]	5 ft	# of trees	30	20	12	5	**68**
		RPI	15%	3%	0%	0%	**19%**

[1/] The numbers presented in this table represent the results of modeling a typical partial cut prescription (21 trees per acre) outside of the RMZ. Modeling clearcut harvest produces similar results (see Table 21), except along Type 4 and 5 streams, where it is assumed that no trees would be left following clearcut harvest.

[2/] The sum of the RPI contributions from all four distance bands is the value used for the final EBAI analysis.

Table 36. Number of Functional Trees and Contribution to the Recruitment Potential Index (RPI) in Each Distance Band, Following Timber Harvest within One 100-year Site Potential Tree Height for Eastside Streams: Alternative 2

Eastside Stream Type	Avg. Stream Width		Band 1 (0-30 ft)	Band 2 (30-75 ft)	Band 3 (75-100 ft)	Band 4 (100-110)	Total[1/] (110 ft)
Alternative 2, Outside Bull Trout Habitat Overlay							
S&F [2/]	5 ft	# of trees	131	52	12	5	**199**
		RPI	65%	8%	0%	0%	**74%**
	12 ft	# of trees	131	52	12	5	**199**
		RPI	65%	8%	0%	0%	**74%**
	25 ft	# of trees	104	52	29	5	**189**
		RPI	65%	10%	1%	0%	**76%**
	45 ft	# of trees	79	22	12	3	**116**
		RPI	65%	6%	0%	0%	**71%**
Inside Bull Trout Habitat Overlay							
S&F [2/]	5 ft	# of trees	131	196	12	5	**344**
		RPI	65%	31%	0%	0%	**96%**
	12 ft	# of trees	131	196	12	5	**344**
		RPI	65%	31%	0%	0%	**96%**
	25 ft	# of trees	104	156	29	5	**294**
		RPI	65%	31%	1%	0%	**97%**
	45 ft	# of trees	79	118	12	3	**212**
		RPI	65%	31%	0%	0%	**97%**
Inside or Outside Bull Trout Habitat Overlay							
N_p (Partial-cut strategy[3/])	5 ft	# of trees	41	39	12	5	**97**
		RPI	20%	6%	0%	0%	**27%**
N_p (Even-aged harvest strategy[3/])	5 ft	# of trees	131	87	0	0	**218**
		RPI	65%	14%	0%	0%	**79%**
N_s (Partial-cut harvest)[4/]	5 ft	# of trees	30	20	12	5	**68**
		RPI	15%	3%	0%	0%	**19%**

[1/] The sum of the RPI contributions from all four distance bands is the value used for the final EBAI analysis.
[2/] The numbers presented for S&F streams represent the results of modeling a typical partial cut prescription (21 trees per acre) outside of the RMZ. Modeling clearcut harvest produces similar results (see Tables 23 and 24, especially within Bands 1 and 2, from which the majority of LWD recruitment occurs.
[3/] See Section 3.3.3.4 for a description of prescriptions assumed under partial cut and even-aged strategies.
[4/] Under an even-aged strategy, no trees would be left within the RMZ of eastside N_s streams under Alternative 2.

3.5 Step 6: Applying RPI Coefficient to streams

The final step of the procedure weights the RPI coefficients by the proportion of each stream size category and water type.

3.5.1 Assumptions

- The proportion of wood delivered to streams changes with channel size (personal communication, R. Bilby, January, 2000). For example, the proportion of a piece of wood falling into a 5-ft wide stream that influences the channel would be less than if the same piece of wood fell into a 25-ft wide stream. Consequently, the length and width of each stream type were both factored into the EBAI calculation.

Table 37. Number of Functional Trees and Contribution to the Recruitment Potential Index (RPI) in Each Distance Band, Following Timber Harvest within One 100-year Site Potential Tree Height for Eastside Streams: Alternative 3

Eastside Stream Type	Avg. Stream Width		Band 1 (0-30 ft)	Band 2 (30-75 ft)	Band 3 (75-100 ft)	Band 4 (100-110)	Total[1/] (110 ft)
Alternative 3							
0-20 % gradient	5 ft	# of trees	131	196	109	44	**480**
		RPI	65%	31%	3%	2%	**100%**
0-20 % gradient	12 ft	# of trees	131	196	109	44	**480**
		RPI	65%	31%	3%	2%	**100%**
0-20 % gradient	25 ft	# of trees	104	156	87	35	**381**
		RPI	65%	31%	3%	2%	**100%**
0-20 % gradient	45 ft	# of trees	79	118	65	26	**288**
		RPI	65%	31%	3%	2%	**100%**
20-30 % gradient	5 ft	# of trees	131	196	109	5	**441**
		RPI	65%	31%	3%	0%	**99%**
20-30 % gradient	12 ft	# of trees	131	196	109	5	**441**
		RPI	65%	31%	3%	0%	**99%**
20-30 % gradient	25 ft	# of trees	104	156	87	5	**351**
		RPI	65%	31%	3%	0%	**99%**
20-30 % gradient	45 ft	# of trees	79	118	65	0	**262**
		RPI	65%	31%	3%	0%	**99%**
30%+ gradient	5 ft	# of trees	131	174	12	5	**322**
		RPI	65%	28%	0%	0%	**93%**
30%+ gradient	12 ft	# of trees	131	174	12	5	**322**
		RPI	65%	28%	0%	0%	**93%**
30%+ gradient	25 ft	# of trees	104	139	12	5	**260**
		RPI	65%	28%	0%	0%	**93%**
30%+ gradient	45 ft	# of trees	79	105	0	0	**183**
		RPI	65%	28%	0%	0%	**93%**

[1/] The sum of the RPI contributions from all four distance bands is the value used for the final EBAI analysis.

- 1st: For each stream type and stream width the landscape channel area is quantified across the landscape.

  For example,

  Type 2 channel area (mi^2) = $\frac{\text{(Type 2 stream miles) (Type 2 stream bankfull width in feet)}}{\text{(5280 feet)}}$

- 2nd: Each stream type channel area is totaled.

- 3rd: Each RPI coefficient is multiplied by the proportion of the total area that a specific stream type falls within a specific prescription.

- Sensitivity analysis (see above, under Step 1) determined that, relative to each other, the RPI values for each alternative exhibited the same pattern, regardless of whether a Mixed Conifer or a Ponderosa Pine stand was used for modeling. Therefore, the RPI coefficients which resulted from modeling of a Site Class II Mixed Conifer stand were applied across the entire landscape.

3.5.2 Results

The EBAI results for each alternative are summarized by the water type system used in that particular alternative. In order to provide a common perspective for comparison, the results of the EBAI were re-summarized using the current stream typing system which were maintained as data tags throughout the calculations. The re-summarized calculations are presented as All Streams (Types 1 – 9 west side, Types 1 – 5 east side), Fish-bearing (Types 1 – 3), Non-fish Perennial (Type 4), and Non-fish Seasonal (Type 5 and 9 west side, Type 5 east side). The results of the EBAI analysis are presented in Figures 11 and 12. These figures graphically display the results for westside and eastside areas, respectively. EBAIs in the figures were calculated as a proportion of the EBAI for a no-harvest strategy over the entire 100-year SPTH for comparative purposes.

3.6 EBAI analysis assuming SPTH for a 250-year old stand

A number of comments on the DEIS expressed concern that criteria for riparian function were based upon SPTH for a 100-year old mature forest stand rather than for an old-growth stand. Suggested stand ages ranged from 200 to 300 years. To examine how this assumption would change the results of the LWD EBAI analysis, Steps 4-6 were repeated using a SPTH for a 250 year-old stand. Representative stand characteristics were the same for the new analysis. Based upon McArdle (1949) and Meyer (1961) the SPTH for 250-year old stands on low Site Class II soils were estimated to be 210 feet for the west side and 170 feet for the east side.

Step 4 was conducted similar to the previous analysis: recruitment potential percentages for each of the four distance bands were estimated based upon McDade et al. (1990). However, for this analysis the old-growth conifer curve rather than the mature conifer curve was assumed to represent LWD recruitment potential. Relative to the previous analysis (Tables 31a and 31b) that assumed mature conifer stand characteristics, the current old-growth (Tables 38a and 38b) analysis decreased the recruitment potential from the inner band (Band 1) and increased the potential from the outer band (Band 4).

Table 38a. Percentage of Total LWD Recruitment Potential Based on Distance to Stream for one SPTH of 210 Feet on the West Side in Fixed Distance Bands[1/]

Region	Band 1 (0 - 50ft)[2]	Band 2 (50 - 80ft)	Band 3 (80 - 100ft)	Band 4 (100 - 210ft)	Total
West side	56.0%	17.0%	7.0%	20.0%	100.0%

[1/] The cumulative percent was presented within fixed distance bands from the streams bankfull width out to the site potential tree height of the stand site class to facilitate comparison between alternatives (see Section 3.0, Step 1, Rationale for details regarding the fixed distance bands)

Table 38b. Percentage of Total LWD Recruitment Potential Based on Distance to Stream for one SPTH of 170 Feet on the West Side in Fixed Distance Bands[1/]

Region	Band 1 (0 – 30ft)	Band 2 (30 -75ft)	Band 3 75 – 100ft)	Band 4 (100 – 170ft)	Total
East side	44.0%	33.0%	9.0%	14.0	100.0%

[1/] The cumulative percent was presented within fixed distance bands from the streams bankfull width out to the site potential tree height of the stand site class to facilitate comparison between alternatives (see Section 3.0, Step 1, Rationale for details regarding the fixed distance bands).

Figure 11. Equivalent buffer area index (EBAI) for LWD summed for all fish-bearing, non-fish bearing perennial, and seasonal streams on the Westside by Alternative Assuming a SPTH for a 100 Year Old Stand

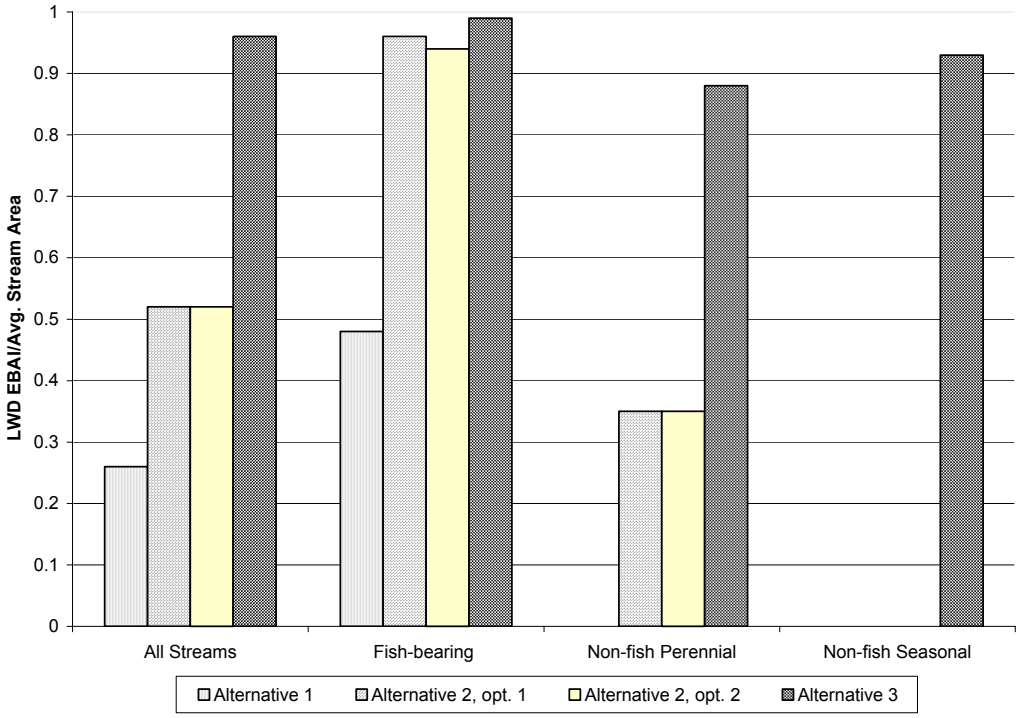
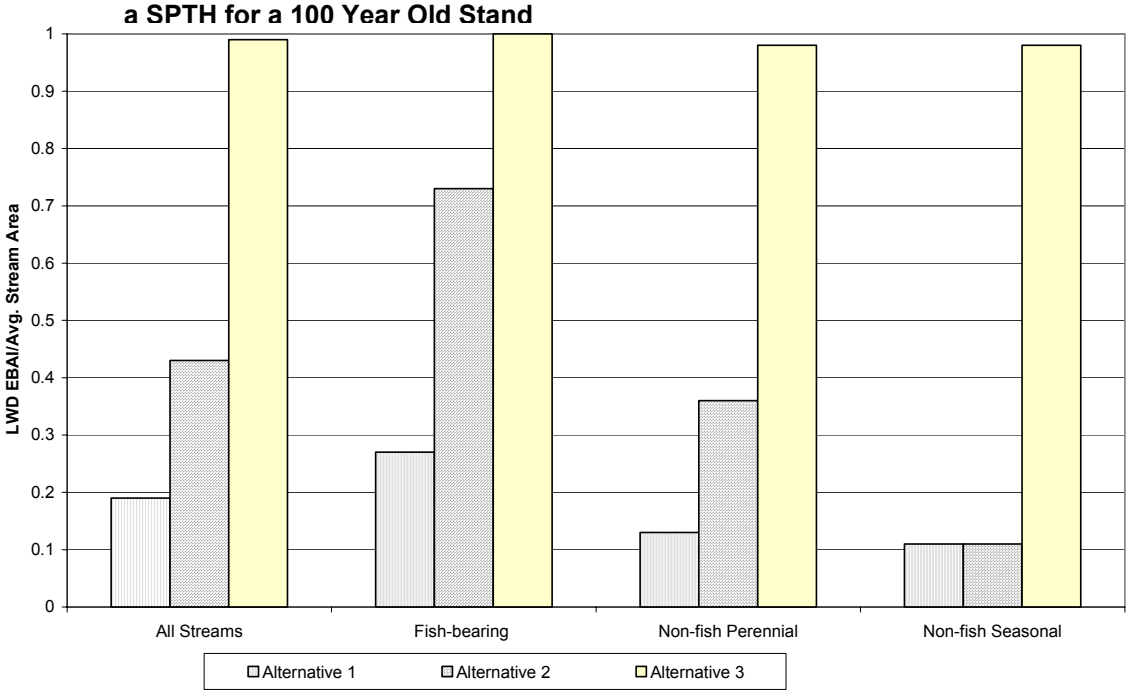


Figure 12. Equivalent buffer area index (EBAI) for LWD summed for all fish-bearing, non-fish bearing perennial, and seasonal streams on the Eastside by Alternative Assuming a SPTH for a 100 Year Old Stand



No changes were made in the procedures for Steps 5 and 6 except that the new results from Step 4 were carried through in the calculation of the RPI coefficients and the EBAI. The results of these calculations are presented in Tables 39 – 44 and Figures 13 and 14. Discussion of these results and the differences between the analyses under the two SPTH assumptions is presented in Section 3.4.3.2 of the EIS.

Table 39. Number of Functional Trees and Contribution to the Recruitment Potential Index (RPI) in Each Distance Band, Following Timber Harvest within One 250-year Site Potential Tree Height of Westside Streams: Alternative 1

Stream Type	Average Stream Width		Band 1 (0-50 ft)	Band 2 (50-80 ft)	Band 3 (80-100 ft)	Band 4 (100-210 ft)	Total [1/] (210 ft)
Alternative 1							
Type 1	44 ft	# of trees	1	0	0	0	**1**
		RPI	45%	0%	0%	0%	**45%**
Type 2	31 ft	# of trees	2	0	0	0	**2**
		RPI	10%	0%	0%	0%	**10%**
Type 3	15 ft	# of trees	39	0	0	0	**39**
		RPI	45%	0%	0%	0%	**45%**
Type 4/5	5 ft	# of trees	0	0	0	0	**0**
		RPI	0%	0%	0%	0%	**0%**

[1/] The sum of the RPI contributions from all four distance bands is the value used for the final EBAI analysis.

4. Comparative Analysis of Time Required for LWD Recruitment

4.1 Introduction

The EBAI focuses on the immediate effects of timber harvest in riparian zones, rather than long-term effects on riparian stand development. The RAIS model was used to analyze the impacts of the different alternatives on stand development and the time required to grow trees that could recruit as functional and key pieces of LWD (up to the 300-year stand age limit of the model). For a discussion of the RAIS model, see "Assumptions for Alternative 2 (Westside RMZs)" above, under Step 2 of the EBAI Methodology section. Because RAIS uses a westside Douglas-fir growth model (ORGANON) to project future stand conditions, long-term LWD input modeling was conducted only for the west side.

4.2 Approach

To model long-term projections of functional LWD input, the RAIS model requires two groups of data parameters: stand data and riparian data. Stand data can be entered for two management regimes (No-Touch and Managed) across four different zones of variable width. For this analysis, the Core Zone (and the Floor of Alternative 2, Option 2) was modeled as No-Touch, and the Inner Zone was modeled as Managed. The model does not allow for a third management regime, thus the Outer Zone could not be modeled.

The parameters required for stand data include 50-year site index, trees per acre (TPA), quadratic mean diameter (QMD), and stand height. RAIS calculates stand age as a function of site index and

Table 40. Number of Functional Trees and Contribution to the Recruitment Potential Index (RPI) in Each Distance Band, Following Timber Harvest within One 250-year Site Potential Tree Height of Westside Streams: Alternative 2

Stream Type	Average Stream Width		Band 1 (0-50 ft)	Band 2 (50-80 ft)	Band 3 (80-100 ft)	Band 4 (100-210 ft)	Total [1/] (210 ft)
Alternative 2, Option 1							
S&F	5 ft	# of trees	84	40	26	43	**193**
		RPI	56%	13%	6%	5%	**80%**
	15 ft	# of trees	49	29	19	27	**125**
		RPI	56%	17%	7%	5%	**85%**
	31 ft	# of trees	13	8	5	7	**33**
		RPI	56%	17%	7%	5%	**85%**
	44 ft	# of trees	2	1	1	1	**5**
		RPI	56%	17%	7%	5%	**85%**
Alternative 2, Option 2							
S&F	5 ft	# of trees	84	50	23	42	**198**
		RPI	56%	17%	5%	5%	**82%**
	15 ft	# of trees	49	29	19	7	**104**
		RPI	56%	17%	7%	1%	**81%**
	31 ft	# of trees	13	8	5	0	**26**
		RPI	56%	17%	7%	0%	**80%**
	44 ft	# of trees	2	1	1	0	**4**
		RPI	56%	17%	7%	0%	**80%**
Alternative 2, Both Options							
N_p (No Harv.)	5 ft	# of trees	84	0	0	0	**84**
		RPI	56%	0%	0%	0%	**56%**

[1/] The sum of the RPI contributions from all four distance bands is the value used for the final EBAI analysis.

stand height; to model effects of timber harvest in a 50-year-old stand, a value for stand height was chosen such that the resulting stand age was as close as possible to 50. To project stand development in the Core Zone, TPA and QMD values were calculated for the original stand. To project stand development in the Inner Zone, TPA and QMD values were calculated for the trees which remained after a timber harvest according to the thinning prescription of Option 1 or Option 2. To provide an indication of the way results would vary with the productivity of a stand, two stands were modeled, a low-productivity Site Class II stand (50-year site index = 119) and a high-productivity Site Class II stand (50-year site index = 128). Site Class II was chosen because it is widespread throughout the westside landscape, and because Option 2 is not available along streams wider than 10 feet within Site Class III, IV, or V stands. The two stands modeled were the same ones used in the sensitivity analysis of the EBAI (see "Sensitivity Analysis" under Step 1 of the EBAI Methodology section, above).

Table 41. Number of Functional Trees and Contribution to the Recruitment Potential Index (RPI) in Each Distance Band, Following Timber Harvest within One 250-year Site Potential Tree Height of Westside Streams: Alternative 3

Stream Gradient	Stream Width		Band 1 (0-50 ft)	Band 2 (50-80 ft)	Band 3 (80-100 ft)	Band 4 (100-210 ft)	Total [1/] (210 ft)
< 20%	5 ft	# of trees	84	50	33	167	**334**
		RPI	56%	17%	7%	18%	**98%**
	15 ft	# of trees	49	29	19	97	**195**
		RPI	56%	17%	7%	18%	**98%**
	31 ft	# of trees	13	8	5	26	**51**
		RPI	56%	17%	7%	18%	**98%**
	44 ft	# of trees	2	1	1	4	**7**
		RPI	56%	17%	7%	18%	**98%**
20-30%	5 ft	# of trees	84	50	33	0	**167**
		RPI	56%	17%	7%	0%	**80%**
	15 ft	# of trees	49	29	19	0	**97**
		RPI	56%	17%	7%	0%	**80%**
	31 ft	# of trees	13	8	5	0	**26**
		RPI	56%	17%	7%	0%	**80%**
	44 ft	# of trees	2	1	1	0	**4**
		RPI	56%	17%	7%	0%	**80%**
> 30%	5 ft	# of trees	84	33	0	0	**117**
		RPI	56%	11%	0%	0%	**67%**
	15 ft	# of trees	49	19	0	0	**68**
		RPI	56%	11%	0%	0%	**67%**
	31 ft	# of trees	13	5	0	0	**18**
		RPI	56%	11%	0%	0%	**67%**
	44 ft	# of trees	2	1	0	0	**3**
		RPI	56%	11%	0%	0%	**67%**

[1/] The sum of the RPI contributions from all four distance bands is the value used for the final EBAI analysis.

Table 42. Number of Functional Trees and Contribution to the Recruitment Potential Index (RPI) in Each Distance Band, Following Timber Harvest within One 250-year Site Potential Tree Height of Eastside Streams: Alternative 1 [1/]

Stream Type	Average Stream Width		Band 1 (0-50 ft)	Band 2 (50-80 ft)	Band 3 (80-100 ft)	Band 4 (100-170 ft)	Total [2/] (170 ft)
Alternative 1							
Type 1	45 ft	# of trees	17	6	0	0	**22**
		RPI	9%	2%	0%	0%	**11%**
Type 2	25 ft	# of trees	42	31	12	34	**119**
		RPI	18%	7%	1%	2%	**28%**
Type 3	12 ft	# of trees	69	40	12	34	**154**
		RPI	23%	7%	1%	2%	**32%**
Type 4/5	5 ft	# of trees	14	22	12	34	**82**
		RPI	5%	4%	1%	2%	**11%**

[1/] The numbers presented in this table represent the results of modeling a typical partial cut prescription (21 trees per acre) outside of the RMZ. Modeling clearcut harvest produces similar results (see Table 21), except along Type 4 and 5 streams, where it is assumed that no trees would be left following clearcut harvest.

[2/] The sum of the RPI contributions from all four distance bands is the value used for the final EBAI analysis.

The parameters required for riparian data include stream width, LWD type (functional size, Bilby and Ward [1989] or key piece), and the widths and management regimes (No-Touch or Managed) for four zones. For this modeling effort, zone widths were determined by the widths of the Core and Inner Zones. Long-term LWD input was modeled for streams of four different widths: 44 feet, 31 feet, 15 feet, and 5 feet. These widths represent the average widths of westside Type 1, 2, 3, and 4/5 streams, respectively.

Long-term modeling compared only Alternative 2 and a no-harvest scenario. The short rotation ages (40 to 60 years) allowable under Alternative 1 preclude the development of functional LWD within RMZs (or, at best, create a scenario too complicated for RAIS to model), and the wide riparian buffers under Alternative 3 act as de facto no-harvest zones of one site potential tree height along most streams.

4.3 Results

The results of long-term modeling indicate that thinning within the RMZ accelerates the initial input of functional LWD into the stream system (Table 45). This pattern shows up only on larger streams (31 and 44 feet), and is more pronounced for key piece LWD rather than for functional LWD. As modeled by ORGANON, thinning accelerates the development of large trees, which become large pieces of LWD when they die. Since small wood provides functional LWD within small streams, the accelerated development of larger trees has no noticeable benefit along 5- and 15-foot streams for obtaining earlier LWD. Similarly, since the minimum size requirements for key piece LWD are larger than for functional LWD, development of the very largest pieces of LWD is most accelerated when fewer large trees are left growing in a stand, rather than when many trees are competing for sunlight and other resources.

Table 43. Number of Functional Trees and Contribution to the Recruitment Potential Index (RPI) in Each Distance Band, Following Timber Harvest within One 250-year Site Potential Tree Height of Eastside Streams: Alternative 2

Stream Type	Average Stream Width		Band 1 (0-50 ft)	Band 2 (50-80 ft)	Band 3 (80-100 ft)	Band 4 (100-170 ft)	Total [1/] (170 ft)
Alternative 2, not in Bull Trout Habitat Overlay							
S&F [2/]	5 ft	# of trees	131	52	12	34	**228**
		RPI	44%	9%	1%	2%	**55%**
	12 ft	# of trees	131	52	12	34	**228**
		RPI	44%	9%	1%	2%	**55%**
	25 ft	# of trees	104	52	29	34	**218**
		RPI	44%	11%	3%	2%	**60%**
	45 ft	# of trees	79	22	12	3	**116**
		RPI	44%	6%	2%	0%	**52%**
Alternative 2, inside Bull Trout Habitat Overlay							
S&F [2/]	5 ft	# of trees	131	196	12	34	**373**
		RPI	44%	33%	1%	2%	**80%**
	12 ft	# of trees	131	196	12	34	**373**
		RPI	44%	33%	1%	2%	**80%**
	25 ft	# of trees	104	156	29	34	**322**
		RPI	44%	33%	3%	2%	**82%**
	45 ft	# of trees	79	118	12	3	**212**
		RPI	44%	33%	2%	0%	**79%**
Alternative 2, inside or outside Bull Trout Habitat Overlay							
N_p (partial cut strategy) [3/]	5 ft	# of trees	41	39	12	34	**126**
		RPI	14%	7%	1%	2%	**23%**
N_p (even-aged strategy) [3/]	5 ft	# of trees	131	87	0	0	**218**
		RPI	44%	15%	0%	0%	**59%**
N_s (partial cut strategy) [4/]	5 ft	# of trees	14	22	12	34	**82**
		RPI	5%	4%	1%	2%	**11%**

[1/] The sum of the RPI contributions from all four distance bands is the value used for the final EBAI analysis.
[2/] The numbers presented for S&F streams represent the results of modeling a typical partial cut prescription (21 trees per acre) outside of the RMZ. Modeling clearcut harvest produces similar results (see Tables 23 and 24), especially within Bands 1 and 2, from which the majority of LWD recruitment occurs.
[3/] See Section 3.3.3.4 for a description of prescriptions assumed under partial cut and even-aged strategies.
[4/] Under an even-aged strategy, no trees would be left within the RMZ of eastside N_s streams under Alternative 2.

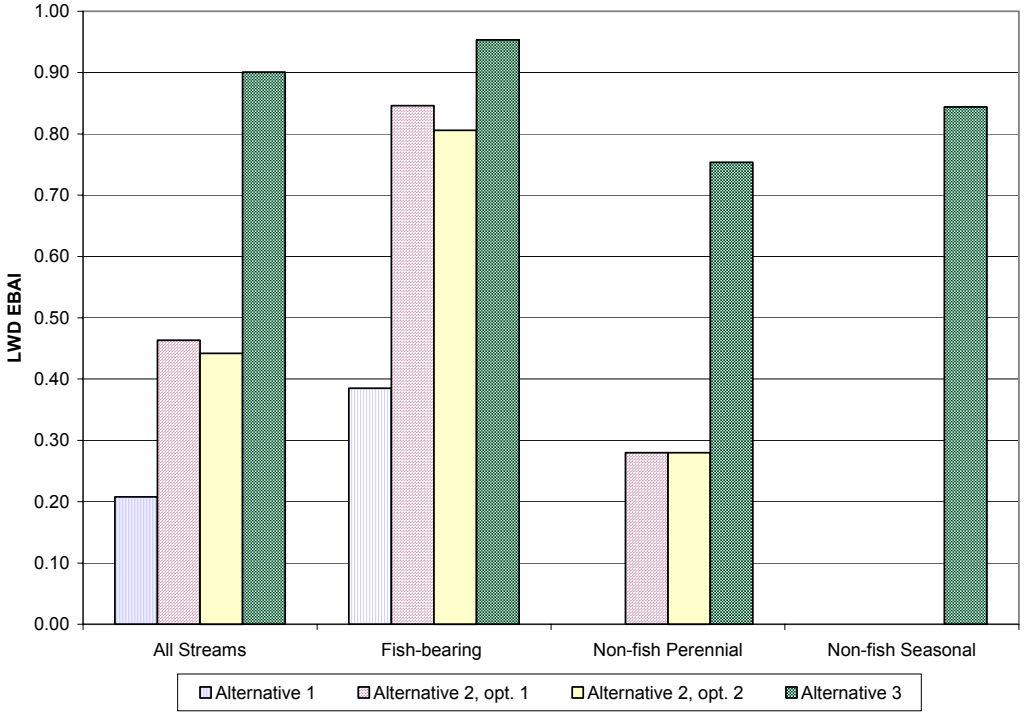
Table 44. Number of Functional Trees and Contribution to the Recruitment Potential Index (RPI) in Each Distance Band, Following Timber Harvest within One 250-year Site Potential Tree Height of Eastside Streams: Alternative 3 [1/]

Stream Gradient	Stream Width		Band 1 (0-50 ft)	Band 2 (50-80 ft)	Band 3 (80-100 ft)	Band 4 (100-170 ft)	Total [2/] (170 ft)
< 20%	5 ft	# of trees	131	196	109	305	**742**
		RPI	44%	33%	9%	14%	**100%**
	12 ft	# of trees	131	196	109	305	**742**
		RPI	44%	33%	9%	14%	**100%**
	25 ft	# of trees	104	156	87	243	**589**
		RPI	44%	33%	9%	14%	**100%**
	45 ft	# of trees	79	118	65	183	**445**
		RPI	44%	33%	9%	14%	**100%**
20-30%	5 ft	# of trees	131	196	109	34	**470**
		RPI	44%	33%	9%	2%	**88%**
	12 ft	# of trees	131	196	109	34	**470**
		RPI	44%	33%	9%	2%	**88%**
	25 ft	# of trees	104	156	87	34	**380**
		RPI	44%	33%	9%	2%	**88%**
	45 ft	# of trees	79	118	65	0	**262**
		RPI	44%	33%	9%	0%	**86%**
> 30%	5 ft	# of trees	131	174	12	34	**351**
		RPI	44%	29%	1%	2%	**76%**
	12 ft	# of trees	131	174	12	34	**351**
		RPI	44%	29%	1%	2%	**76%**
	25 ft	# of trees	104	139	12	34	**288**
		RPI	44%	29%	1%	2%	**77%**
	45 ft	# of trees	79	105	0	0	**183**
		RPI	44%	29%	0%	0%	**73%**

[1/] The numbers in this table represent the results of modeling a typical partial cut prescription (21 trees per acre) outside of the RMZ. Modeling clearcut harvest produces similar results, especially within Bands 1 and 2, from which the majority of LWD recruitment occurs.

[2/] The sum of the RPI contributions from all four distance bands is the value used for the final EBAI analysis.

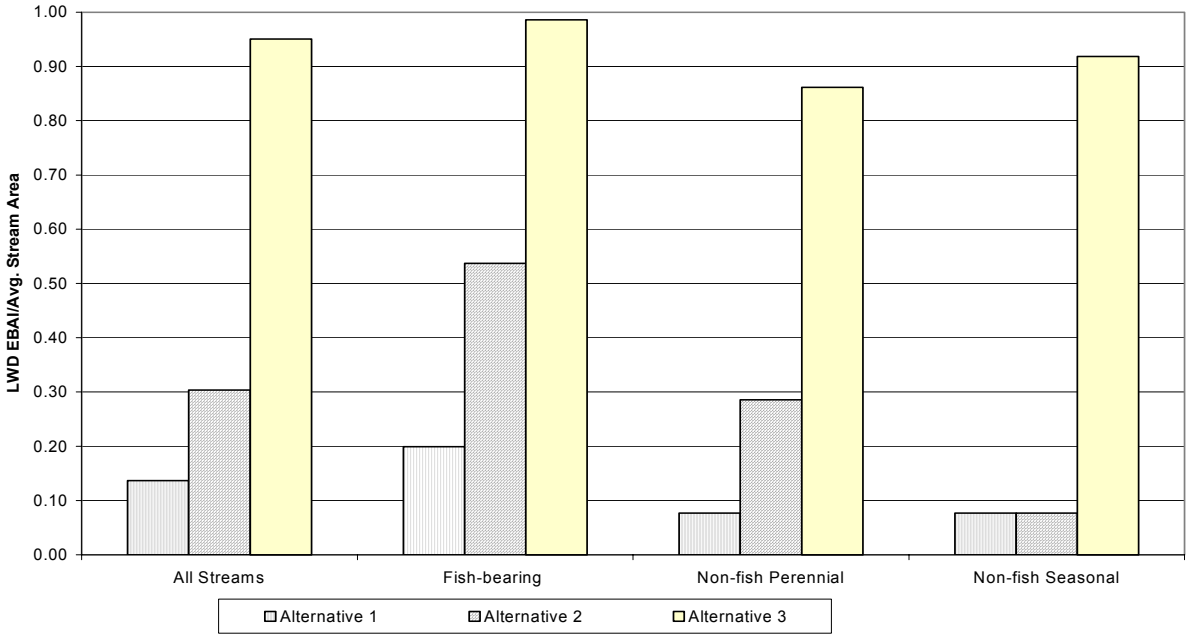
Figure 13. Equivalent Buffer Area Index (EBAI) for LWD Summed for All, Fish-bearing, Nonfish-bearing Perennial, and Seasonal Streams on the West Side, by Alternative Assuming $SPTH_{250}$



The most dramatic illustration of the trend of accelerated LWD input occurs for key piece LWD in 44-foot streams within high-productivity Site II stands. Under the no-harvest scenario (equivalent to Alternative 3 for a stream with a gradient less than 20 percent), initial input of key piece LWD occurs at 290 years. Under Alternative 2 Option 2 (which includes a no-harvest buffer of 100 feet, with thinning allowed beyond that), initial input occurs at 210 years. Under Alternative 2 Option 1 (which includes a 50-foot no-harvest buffer, and an Inner Zone prescription of thinning from below), initial input occurs at 160 years (Table 45).

In addition to obtaining key piece LWD sooner through thinning, this silvicultural practice may also increase the number of pieces of functional or key piece LWD. For example, after 300 years, Option 1 (for a high Site Class II stand) for a 44-foot wide stream provided 14 percent more functional pieces of LWD per 1,000 feet of stream compared to Option 2. Consequently, thinning can provide benefits in terms of both quantity and timing of LWD recruitment.

Figure 14. Equivalent Buffer Area Index (EBAI) for LWD for All, Fish-bearing, Nonfish-bearing Perennial, and Nonfish-bearing Seasonal Streams on the East Side, by Alternative Assuming $SPTH_{250}$



Notably, within the 300-year timeframe of the RAIS model, this pattern is almost invisible for a low-productivity stand. Presumably, the slower growth rate of trees on such sites delays the development of pieces large enough to serve as functional LWD.

Table 45. Stand Age (to the nearest 10 years) at Initial Input of Functional LWD, for High- and Low-productivity Site Class II Riparian Stands, Under a No-harvest Scenario and Under Options 1 and 2 of Alternative 2

	Key Piece LWD				Bilby and Ward LWD			
Stream Width:	**44 feet**	**31 feet**	**15 feet**	**5 feet**	**44 feet**	**31 feet**	**15 feet**	**5 feet**
Site Class II High (SI = 128)								
Alternative 2 Option 1	160	160	160	90	160	130	100	80
Alternative 2 Option 2	210	180	160	90	150	130	100	80
No Harvest (Alternative 3)	290	180	160	90	170	130	100	80
Site Class II Low (SI = 119)								
Alternative 2 Option 1	>300	250	180	100	180	150	110	80
Alternative 2 Option 2	>300	260	180	100	190	150	110	80
No Harvest (Alternative 3)	>300	260	180	100	190	150	110	80

5. Equivalent Buffer Area Index (EBAI) Methodology for Sediment Filtration

5.1 Introduction

The equivalent buffer area index (EBAI) was devised as a crude assessment of risk for streams in relation to management activities. It is similar in concept to the equivalent road area (ERA) analysis of McGurk and Fong (1995) and the non-point source risk assessment of Lull and others (1995). However, while those studies developed a method to assess sediment contribution from management activities, the EBAI is relative measure of the protection of streams *from* fine sediment derived from hillslope erosion and from road surface erosion. In addition, the EBAI concept is used to evaluate contribution of large woody debris (LWD) from proposed or existing riparian buffers.

It was necessary to develop the EBAI because studies in the literature typically evaluate buffer widths based on "no harvest", or preservation of mature forest with no disturbance. New management strategies include riparian areas that are divided into zone with different levels of timber harvest related activities and thus are not directly comparable to the buffers in the alternatives. Similarly, existing buffer strips in a given watershed may be a mixture of widths and activities, as a result of multiple jurisdictions, or forest practice rules that have changed over time.

5.2 Approach

The EBAI provides a structure to take into account the management activities within the buffer zone. It combines the impacts of activities within the riparian management area (RMA) to compare the effectiveness of the RMA at filtering sediment and the potential to recruit LWD. In addition, because the buffer requirements for sediment filtration and LWD recruitment are more restrictive than buffer requirements for protection of other riparian functions (e.g. stream temperature, and detrital inputs (Johnson and Ryba, 1992; Spence et. al., 1996), the EBAI can also be used to compare relative protection for those parameters as well.

The ability of a vegetated buffer strip to filter sediment has been shown in numerous studies (e.g., Wilson, 1967; Ermann et al., 1977; Lynch et al., 1977). This effect is a result of the vegetation intercepting overland flow, slowing it down, and allowing fine sediment to settle out. This effect is limited to flow coming from hillslope erosion; channelized flow through existing drainages remains unaffected, since there is not sufficient vegetation in most channels to filter out fine sediment. Potential sources of fine sediment in overland flow include erosion from hillslope logging activities, and road surface erosion that comes from drainage relief culverts (road surface erosion from ditches is unaffected because it directly enters stream at road crossings).

5.3 Assumptions

As in the ERA, this method uses coefficients assigned to various timber management practices based partly on the literature and partly on professional judgment. This reflects the relative ranking of these silvicultural practices presented in McGurk and Fong (1995).

The highest coefficient used is 1.0, representing no harvest, which is the highest amount of protection. Any activity within the RMZ that removes trees or disturbs the soil reduces the coefficient. The lowest coefficient possible is zero, which is associated with building a road in the riparian zone. The relative impact of various activities was used to assign the coefficients. In addition the silvicultural system used (clearcut or selective harvest) was used to refine coefficients.

A further refinement was made based on the relative number of trees left in the RMZ. "Thinning" (renamed "light") was assigned a higher coefficient than selective harvest ("heavy"), which in turn was assigned a higher coefficient than clearcutting, which is the most disturbing level of harvest. Table 46 shows the coefficients used for each type of harvest practice.

Table 46. EBAI (sediment input) Coefficients Associated with Various Management Activities within RMZs

No harvest	1.0
Cable, light ('thinning')	0.9
Cable, heavy	0.8
Cable, clearcut	0.7
Shovel, light ('thinning')	0.8
Shovel, heavy	0.7
Shovel, clearcut	0.6
Tractor/skidder, light ('thinning')	0.7
Tractor/skidder, heavy	0.65
Tractor/skidder, clearcut	0.6
Road	0.0

Relevant yarding methods, from most to least protective, are as follows: cable, shovel, and tractor/skidder. For simplicity, no distinction was made between tractors and skidders.

In addition, to address ground based yarding methods, a general rule had to be developed. Based on a conversation with Charlene Rogers of the DNR (October 28, 1999 to Garrett Jackson, Foster Wheeler Environmental Corporation), ground-based methods are commonly used on areas that are less than 35 percent in slope. In addition, shovel yarding is used more commonly on the western side of the Cascades, for slopes less than 30 percent, while skidders are the method of choice on the east side, on slopes up to 35 percent. To simplify the analysis, a break of 30 percent was used for both the east and west sides of the Cascades. Thus, the EBAI for the east side may be somewhat understated.

The EBAI is calculated by multiplying the management coefficient by the width over which it is applied. Where multiple activities occur in the RMZ, the products of coefficient and width for each activity are summed. The EBAI ignores activities that overlap or cross multiple management areas (e.g., grazing), since these appear to be consistent among the alternatives. The width of buffer management is important for comparison purposes. Recommended buffer widths for sediment filtration vary widely, from 30 feet (Rashin et al., 1999) to over 300 feet (Wilson, 1967: O'Laughlin and Belt, 1994). To calculate the EBAI, a buffer width must be selected. Because of the range in values for sediment filtration, two widths were used, and thus two different EBAIs were developed. Thirty feet was chosen to represent the lower end of the values recommended in the literature, while 170 feet was chosen based on Spence and others' (1995) synthesis of the literature.

Ultimately, the index incorporates effects to all streams, regardless of class, into a single number for each hydrologic unit or region. This is done by multiplying the sum of the coefficients (see equation below) by the length of the stream miles associated with that class. Then the results for each stream class are totaled. If a watershed has multiple owners with different RMA management activities, these can be accounted for.

$EBAI_i = [(w_1*C_1) + (w_2*C_2)+ (w_x*C_x)] R_I + [(w_1*C_1) + (w_2*C_2)+ (w_x*C_x)] R_{II} + [(w_1*C_1) + (w_2*C_2)+ (w_x*C_x)] R_{III}$

5.4 Results

The results of the EBAI calculations are shown in Figure 15. This figure shows the EBAI calculated for each alternative based on a 30-foot buffer. Here the EBAI has been refined one step further to highlight the difference in buffers between the east and west parts of the state. The EBAI was divided by the total river miles in the sample areas in both regions. With the 30-foot buffer, little difference exists between the sediment filtration for east and west parts of the state, under each of the alternatives. There are differences between the alternatives, however.

Alternative 1 would provide an EBAI of 0.0037, or about 64 per cent of the EBAI of the reference buffer. The EBAI of Alternative 2 (which is identical under both options) would be about 79 per cent of the reference EBAI. The EBAI of Alternative 3 would be 100 percent of the reference buffer EBAI; it requires no harvest buffers that are greater than the minimum 30 foot buffer.

Figure 16 shows the results based on a 170-foot buffer. This shows that if 170 feet is considered complete protection for sediment filtration, a slightly different set of EBAIs results. Alternative 1 would provide an EBAI of about 62 percent of the EBAI of the 170-foot reference buffer. Alternative 2, Option 1, would have about the same EBAI alternative 1. However, under Option 2, the EBAI is significantly higher on the west side streams than the eastside streams, being 79 per cent of the reference buffer EBAI. Alternative 3 would provide an EBAI that is 93 percent of the reference EBAI.

The pattern of EBAI values amongst the alternatives are similar overall whether 30 or 170 feet is used for the reference buffer. This indicates that the difference in sediment filtration outside the 30 foot buffer (i.e., between 30 and 170 foot) is not great. This may be a result of the selection of coefficients; the coefficients for clear cuts and for partial cuts (or for that matter, no harvest) may not be sensitive enough to highlight the differences. However, the EBAI is sensitive enough to distinguish the overall difference in sediment filtration provided by the alternatives.

Figure 15. Normalized EBAI, 30-foot buffer

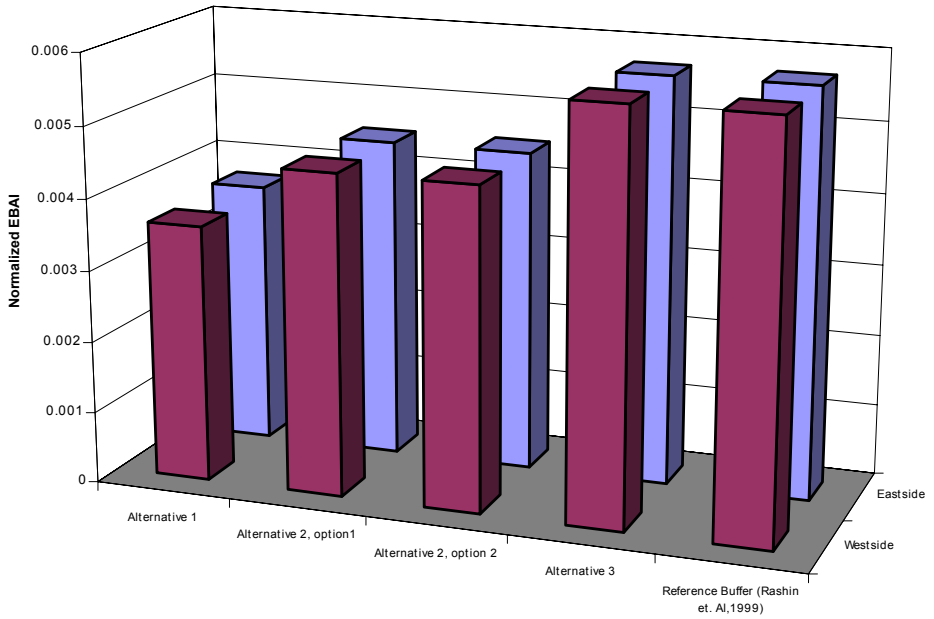
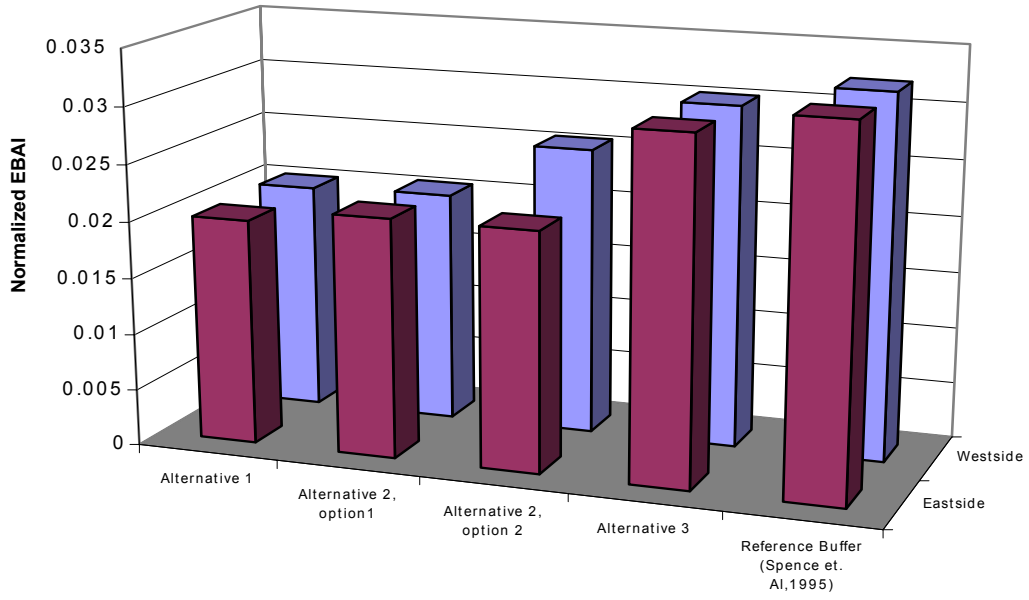


Figure 16. Normalized EBAI, 170 foot buffer



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